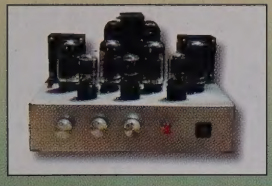
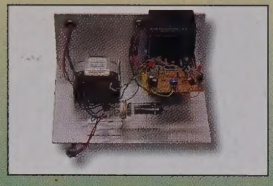


Joseph Still
page 20
**Plenty of Power ...Cheap!**



Wim de Haan
page 30
**DIY Hybrid Amp**

Hansen & the Ketlers
page 33
**Super Amp Lives Up to Its Name**

*Volume 12 Number 5 2000*

www.audioXpress.com

$7.00
CANADA $10.00

# GLASS AUDIO

# Paralleling Tubes Effects

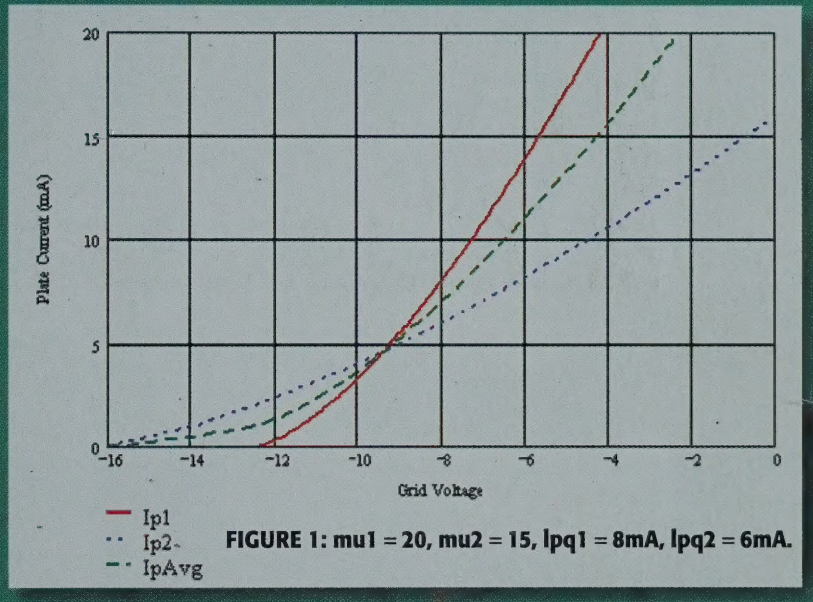



**FIGURE 1: mu1 = 20, mu2 = 15, Ipq1 = 8mA, Ipq2 = 6mA.**

**BY MATT KAMNA, DAVE MCDONALD, & KEN BOEHLKE**

Many hobbyists and professionals who have seen or built many tube circuits may remember some that had paralleled tubes. For example, high-power amplifiers used either push-pull outputs or more powerful tubes. The only other alternative for linear tube amplifiers is parallel operation.

Some folks in the audio community claim that paralleling tubes does not give good sonic results. Perhaps there might be some problems or effects with the linearity of combined tubes. This article explores the subject in a detailed and methodical way in an attempt to clear up some of the concerns or confusion around this design tool.

*to page 12*

05
0 74470 84698 7

# Welborne Labs

Products by:

Allen Bradley
Alps
BlackGate
Caddock
CAIG Labs
Cardas
DH Labs
Elna Cerafine
Golden Dragon
Grayhill
Hammond
Holco
Hovland MusiCaps
Hubble
Jensen
Kimber
KR Enterprise
LCR Caps
Lowther
Mills
MultiCap
Neutrik
Noble
OCSL
PFT Chassis
Ram Labs
Roederstein
Solen
Sorbothane
Sovtek
Svetlana
Tesla
Vampire
WBT
Western Electric
Wima
Yamamoto
and many more...

Tube Linestages

Passive Linestages

Phonostages

Single-Ended Amps
from 2.5W to 25W

AC Conditioners

Mods & Modules

Reveille Linestage

Apollo II

Moondog 2A3

High Quality High-Fidelity Kits and Assembled Products

Largest Selection of Components and Accessories

The Most Informative Catalog in the Business

Celebrating our 12th Anniversary 1988 - 2000

Visit Our On-Line Store
http://www.welbornelabs.com

*Reader Service #37*

Our 2000 Catalog & Design Manual features loads of kits, parts, books, software, schematics, fun projects and the usual information. It's just $10 U.S. and Canada, $18 International, refundable. Visa and Mastercard accepted. International orders are welcome.

P.O. Box 260198, Littleton, CO 80126 USA Phone: 303.470.6585 Fax: 303.791-5783

# "Remarkable!"

– M.S., Atlanta GA

- **Yes, we're delivering the goods.**
  *Our production is now in full swing.*
- **And our customers are telling us they really like what they hear.**
  *The quotes below are just the tip of the iceberg.*
- **You can take a pair for a test drive in your own system and let us know what you think.**
  *Order direct, risk-free. 30-day money-back guarantee. If you don't love it, return it.*

**P•3A DAC**
High Resolution 24/96~24/192~DSD
Digital-to-Analog Converter – $699 msrp

*"What first impressed me about P•1A is the tremendous definition, especially in the lower end..."*

– J.P., Milwaukee WI

*"Boy, was I blown away... The sound was smooth, smooth, smooth...*

*It was the first time I really could identify some of the acoustics in which the recording took place.*

*The P•3A is simply a wonderful DAC. It sounds smooth and liquid with voices, enlarges image depth and height, and provides high resolution, yet, it's even better in combination with the P•1A in all those aspects..."*

– V.H., Cupertino CA

*"If I had heard the P•1A and didn't know what it cost, I'd have expected $3000–4000 based on the level of sonic improvement. The best $950 I ever spent on audio!"*

– J.S., Lancaster KY

**P•1A Digital Correcton Engine**
DSP-based Resolution Enhancement
Loudspeaker+Loudspeaker/
Room Correction System – $950 msrp
*Upgrades your 16-Bit 44.1 CDs to the new 24-Bit 96KHz standards*

*"The P•1A is a remarkable product. It cleans up the whole sound in an astonishing way!*

*The bass is tighter, the midrange is free of grain and the treble is clearer. It's a remarkable improvement. Wow!!!"*

– P.W., Sweden – *on the P•1A with interpolation/upsampling only*

PERPETUAL TECHNOLOGIES

**Want to learn more?**

## See our newly-designed website!

*Order yours direct with a 30-day money-back guarantee.*
*Call or visit our website today.*

**www.perpetualtechnologies.com**
*toll-free* **(877) 543-7500**

**Perpetual Technologies, LLC**
*voice* (303) 543-7500 • *fax* (303) 543-7200
*email us at* sales@perpetualtechnologies.com

Reader Service #92

Tel/Fax: 7-095-1124422 E-mail: contact@tubes.ru

# STC NavigatoR

NavigatoR Ltd company specializes in trading Russian vacuum tubes for:

*audio*
*amateur radio*
*broadcasting*
*industry*
*meteorology*
*communication*
*medical applications*
*navigation*

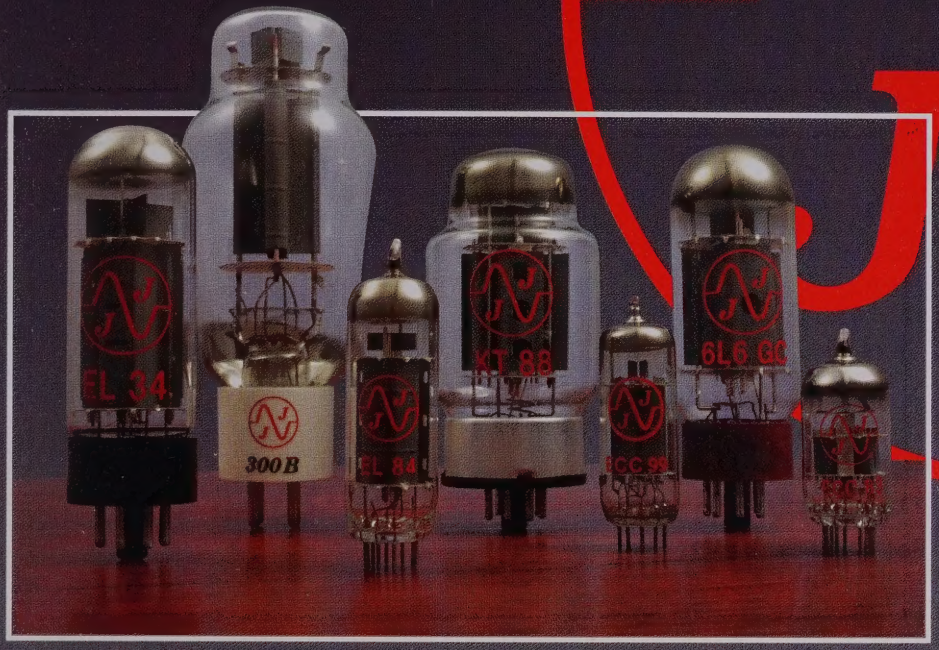
***Amateur Radio Tubes***
***Audio Tubes***
***Broadcasting Tubes***
***Cathode Ray Tubes***
***Ceramic Tubes***
***Control Tubes***
***CWT***
***Diodes***
***Display Tubes***
***Electron Tubes***
**Glass Tubes**
**Hi-End and *Hi-Fi Audio Tubes***
***Hydrogen Thyratrons***
***Ignitrons***
***Industrial Tubes***
***Klystrons***
***Magnetrons***
***Modulator Pulse Tubes***
***Modulator Tubes***
***Noise Source Tubes***
***Nuvistor Tubes***
***Pencil Tubes***
***Pentodes***
***Photodiodes***
***Readout Tubes***
***Receiving Tubes***
***Rectifiers***
***RF Amplifier Tubes***
***Spark Gap Tubes***
***Subminiature Tubes***
***Tetrodes***
***Thyratrons***
***Transmitting Pulse Tubes***
***Transmitting Tubes***
***Travelling Wave Tubes (TWT)***
***Vacuum Capacitors***
***Vacuum Relays***
***Vidicons***
***Voltage Reference Tubes***

For more information visit our web site www.tubes.ru

*Reader Service #99*

# JJ ELECTRONIC

EXCELLENCE WITH EVERY DECIBEL




- ELECTRON TUBES, PARTS
- HI-END AMPLIFIERS

JJ Electronic, A. Hlinku 4, 022 01 Cadca, SLOVAKIA
Tel.: 00421/824/432 55 38, Fax: 00421/824/432 51 72
www.jj-electronic.sk, E-mail: jj.electronic@bb.telecom.sk

Reader Service #2

# A MAJOR ANNOUNCEMENT *From the Publisher*

My friends,

Just over 30 years ago we set out on a journey into publishing a magazine about audio construction with high hopes and not a little apprehension. I feel that we are at a very similar threshold here in the last quarter of 2000. I am very pleased to announce the launch of a brand new periodical, *AudioXpress*, whose first edition will mail to you in late December.

*AudioXpress* will combine *Audio Electronics, Speaker Builder*, and *Glass Audio* in a monthly magazine. As a subscriber to one or more of our current titles, you will be receiving the new periodical for the full number of issues for which you have already subscribed. This means that whatever number of magazines are left in your current subscription(s) will be mailed to you on a monthly schedule. If you subscribe to two of our magazines, we will add together the number of each remaining in your subscription and extend your *Audio Xpress* subscription for that number of issues.

## WHY ARE WE DOING THIS?

First, we expect to build a balanced periodical for you which will contain the same number of articles, or more, on electronics, speakers, and tube gear, respectively, in the course of 2001 and beyond. There will be larger coverage of new products, letters, and showcases of equipment. There will be a major expansion of the review section, which will include all manner of equipment in which any audiophile might be interested.

Second, we believe it will strengthen our effort to offer you a magazine about audio design and construction which will be larger and more powerful. It will increase the effectiveness of advertisers' investment in ad space. It will, we believe, attract some advertisers who have never been interested in our smaller-sized periodicals.

Three, it will give us space to expand our reviews of all kinds of equipment, which broadens our coverage of the audio field. Since we have wanted to offer more reviews, the broader platform of *AudioXpress* will more naturally accommodate the entire audio chain.

Four, we hope that a combination of technologies will make it easier to deal with complete systems of components and the ways these interact with each other. I suspect that even the most dedicated glass enthusiasts have systems that are "hybrid" mixes between solid state and tubes.

Five, we will be coming to you every month, which should reduce problems about when you are going to receive your next issue. We will deliver multi-part articles with less lag time between installments. This speeds up correspondence interchange and provides faster answers to reader questions.

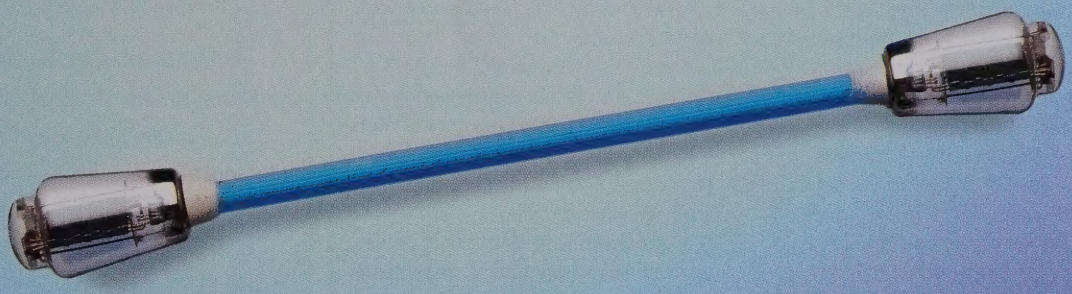
Each article's opening page will include a small icon which identifies its technology: tubes, solid state, or speakers. However, if you think about it, CD players, turntables, arms, phono cartridges, equipment racks, and cabinetry do not fit any one of our present periodicals better than another.

It is our intention to offer you everything you subscribed for in any one of our three current consumer periodicals, with the added bonus of audio-related coverage for which you did not subscribe.

I, and all of us on our staff, deeply appreciate your loyalty and support over the more than 30 years of our existence. We hope you will continue to trust us to do our very best for all of your needs for audio technology information.—E.T.D.

Reader Service #10

# Let your ears rediscover the beauty of pure sound.



Get your tubes at Halfin S.A. and hear the difference. Cleaner, clearer, smoother and with a warm tone; your amp will sound better than ever at a competitive price. Want to be impressed? Then contact Halfin S.A. In the tube business since 1947.

HALFIN

HALFIN SA • Quai aux Pierres de Taille 37/39 • 1000 Brussels • BELGIUM

Phone: + 32-2-218.10.11 • http: //www.halfin.com • Fax: + 32-2-218.69.98 • e-mail: michael@halfin.com

Reader Service #4

# ABOUT THIS ISSUE

What differences—if any—do listeners hear between a parallel and non-parallel tube configuration? A trio of tube enthusiasts—**Matt Kamna, Dave McDonald,** and **Ken Boehlke**—with many years' experience in the electronics industry, attempts to answer this question by providing a very detailed (over two years in the making) analysis of the benefits and disadvantages of operating tubes in parallel ("Paralleling Tubes Effects," p. 1).

We are pleased to present yet another design by audio veteran **Joseph Norwood Still** ("A 20W $260 Amplifier," p. 20). This one was specifically designed for the budget-minded audiophile looking for a high-performance amp.

**Wim de Haan** presents an amp that is hybrid in more ways than one. Combining tubes and solid-state, and ideas from the past and the present, this attractive design features a tube, interstage transformer, and power MOSFETs ("A Hybrid Amp Revisited," p. 30).

We've rounded up an interesting assortment of products for comprehensive review in this issue. First is the AE-25 Super Amp. According to reviewers **Charles Hansen** and **Ken** and **Julie Ketler**, this amp from Audio Electronics Supply is aptly named (p. 33).

Next comes the SL-60 two-way mini-monitor. **Joe D'Appolito** and **Rita** and **Dennis Colin** do the honors for these small, professional-looking speakers (p. 36).

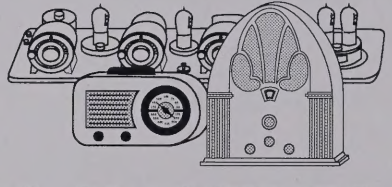
Rounding out the group is the HA-2 model headphone amp from Wheatfield Audio, reviewed by **Charles Hansen**, with listening critique provided by **Jane** and **Richard Honeycutt**. This vacuum-tube unit achieves good marks for construction and performance (p. 39).

In other reviews in this issue, **Charles Hansen** tests the resurrected 2A3 triode from New Sensor ("Product Review," p. 46), and **Larry Lisle** takes a look at a new edition of a popular classic on tube amp design and construction ("Book Report," *Valve Amplifiers*, p. 66).

Finally, if you're like many *GA* readers who prefer the superb sound of a single-ended amp, then you'll enjoy **David George**'s interesting design, which makes use of the popular 6AS7G (p. 42).


**FREE SAMPLE**

*IF YOU BUY,*
*SELL, OR COLLECT*
*OLD RADIOS, YOU NEED...*



**ANTIQUE RADIO CLASSIFIED**

**Antique Radio's Largest Monthly Magazine**
100 Page Issues!
Classifieds - Ads for Parts & Services - Articles
Auction Prices - Meet & Flea Market Info. Also: Early TV, Art Deco, Audio, Ham Equip., Books, Telegraph, 40's & 50's Radios & More...
*Free 20-word ad each month for subscribers.*
**Subscriptions: $19.95 for 6-month trial.**
**$39.49 for 1 year ($57.95 for 1st Class Mail).**
*Call or write for foreign rates.*

**Collector's Price Guide books by Bunis:**
**Antique Radios, 4th Ed.** *8500 prices, 400 color photos* .....$18.95
**Transistor Radios, 2nd Ed.** *2900 prices, 375 color photos* .....$16.95
*Payment required with order. Add $3.00 per book order for shipping. In Mass. add 5% tax.*

MasterCard **A.R.C., P.O. Box 802-A16, Carlisle, MA 01741** VISA
**Phone: (978) 371-0512 — Fax: (978) 371-7129**
**Web: www.antiqueradio.com — E-mail: ARC@antiqueradio.com**

*Reader Service #3*



GLASS AUDIO®

## The Staff

Edward T. Dell, Jr. Editor and Publisher

Regular Contributors

Eric Barbour, Charles Hansen, Don Jenkins

Karen Hebert Vice President
Dennis Brisson Assistant Publisher
Swain Pratt Associate Editor
Marianne Conway Editorial Assistant
Tina Hoppock Graphics Director
Melinda Taylor Production Assistant
Amy K. Wyman Production Assistant
Laurel Humphrey Marketing Director
Kelly Bennett Customer Service

Advertising

Janet Hensel Advertising/Account Coordinator
Nancy Vernazzaro Advertising/Account Coordinator
Beverly Poirier Special Projects Account Manager

Advertising Representation
**Nelson & Associates**
Ken Nelson 914-476-3157
Dan Nelson 914-476-1225
62 Wendover Road, Yonkers, NY 10705
Fax: 914-969-2746, E-mail: dknskn23@aol.com

**EDITORIAL** — Send manuscripts, letters, questions, and comments to: Glass Audio, Editorial Dept., PO Box 876, Peterborough, NH 03458, FAX (603) 924-9467, E-mail: editorial@audioXpress.com.

**CIRCULATION** — For subscriptions, renewals, back issues, or address changes, write to the Circulation Dept. (PO Box 876, Peterborough, NH 03458) or call (603) 924-9464 or FAX (603) 924-9467 E-mail: custserv@audioXpress.com.

**ADVERTISING** — Address advertising inquiries and information requests to the Advertising Dept., PO Box 876, Peterborough, NH 03458, (603) 924-7292, FAX (603) 924-9467, E-mail: advertising@audioXpress.com



Copyright ©2000 by Audio Amateur Corporation. All rights reserved.



**Glass Audio** (US ISSN 1045-5027) is published bimonthly (6 issues), at $28 per year; Canada add $6 per year; overseas rates: $47 one year; by Audio Amateur Corporation, at 305 Union Street, PO Box 876, Peterborough, NH 03458-0876.

Periodicals postage paid at Peterborough, NH and an additional mailing office. POSTMASTER: Send address change to Glass Audio, 305 Union St., Peterborough, NH 03458-0876.

PO Box 876 Dept G00
Peterborough, NH 03458-0876




Postage Required
Post Office will not deliver without proper postage.



**RETURN ADDRESS (Please Print)**

Name _____

Address _____

City _____

State _____ Zip _____

# VACUUM TUBES AND AUDIO

A natural marriage of smooth sound and a warm glow and the most fun to be had today in audio construction!

Discover the fun provided by our authors testing the limits of audio design with tubes.

And, read Audio Classroom, a collection of articles reprinted to help you learn about the fascinating world of vacuum tubes.

Get the best tube information for your dollar from *Glass Audio*!

***SUBSCRIBE TODAY AND SAVE 1/3 off the cover price!***

IMPORTANT: BE SURE TO ENCLOSE YOUR CHECK, MONEY ORDER OR CHARGE INFORMATION.

FOLD HERE

# SAVE UP TO 1/3

*off the cover price with a subscription!*

GLASS AUDIO

Subscribe now and save 33% off the cost of buying *Glass Audio* on the newsstand. And, get home delivery. This card is from issue number

1 2 3 4 5 6 (circle one)

*YES!* **I want every issue of *Glass Audio* delivered to me, sign me up for:**

- ☐ 2 years (12 issues) at $50.00 *(SAVE ⅓)*
- ☐ 1 year (6 issues) at $28.00 *(SAVE ⅓)*

**Canada/Mexico** add $6 per year. Overseas rates: 1 year–$47; 2 years–$83. Remit in US $ drawn on a US bank only.

NAME

ADDRESS

CITY

STATE ZIP

COUNTRY PHONE

*Allow 4-6 weeks for delivery of first issue. Rates subject to change.*

**METHOD OF PAYMENT**

☐ Check or money order ☐ Mastercard ☐ VISA
☐ American Express ☐ Discover

CARD NO. EXP. DATE

SIGNATURE

TEAR ALONG DOTTED LINE, FOLD OVER, AND SEAL

**New old Stock – Government or original boxes unless marked * which are White box**

**On these types ONLY you can obtain these WHOLESALE prices for a MINIMUM ORDER ONLY £50**

| | 1–19 | 20–49 | 50–99 | 100–199 | 200+ |
|---|---|---|---|---|---|
| | £ each | £ each | £ each | £ each | £ each |
| 2A6 Fivre Italy | £3.30 | £2.20 | £1.50 | £1.50 | £1.40 |
| 2C51 Russian guarantee Equivalent to 5670 | £0.60 | £0.60 | £0.40 | £0.40 | £0.40 |
| 3D21 STC. Data available | £12.00 | £9.50 | £9.50 | £7.50 | £7.00 |
| 4D32 EEV/Raytheon | £17.00 | £14.00 | £12.00 | - | - |
| 5B-254M STC UK | £9.99 | £6.66 | £5.00 | £4.00 | £4.00 |
| 5B-255M STC UK | £12.75 | £8.50 | £6.50 | £4.50 | £4.25 |
| 6AG7* Russian | £1.50 | £1.00 | £0.95 | £0.90 | £0.85 |
| 6AK5 Mullard | £1.95 | £1.95 | £1.95 | £1.95 | £1.30 |
| 6AL5 Mullard UK | £1.50 | £1.50 | £1.00 | £0.95 | £0.95 |
| 6AM4 GE USA | £2.00 | £2.00 | £1.50 | £1.45 | £1.40 |
| 6AM6 = EF91, Mullard | £1.20 | £1.20 | £0.80 | £0.70 | £0.60 |
| 6AU5GT GE USA | £2.50 | £2.00 | £1.90 | £1.80 | £1.70 |
| 6AM5 Mullard UK | £3.00 | £2.00 | £1.60 | £1.35 | £1.25 |
| 6AK6 Brimar UK | £1.00 | £0.65 | £0.45 | £0.38 | £0.38 |
| 6AU5GT GE USA | £2.50 | £2.00 | £1.90 | £1.80 | £1.10 |
| 6AU6WC* USA | £1.43 | £1.43 | £0.95 | £0.85 | £0.66 |
| 6AU8A GE/RCA USA | £0.75 | £0.75 | £0.75 | £0.75 | £0.75 |
| 6B4G Use 6AU5GT for near equivalent. Re-wire original base to make a near equivalent to 6B4G. Data available. | | | | | |
| 6BW6 Brimar UK, very similar to 6V6G but different base. Data available | £2.75 | £2.75 | £2.75 | £1.50 | £1.40 |
| 6C33CB Russian. *No discounts possible* | £15.60 | £12.20 | £11.30 | - | - |
| 6CW4 Use 8203, which has the same base connections to 6CW4 but is lower μ. Data available | | | | | |
| 6V6GT Use 6BW6 Brimar UK | | | | | |
| 7V7 Sylvania USA | £1.43 | £1.43 | £0.95 | £0.95 | £0.95 |
| 12AT7 See ECC91 which is a possible alternative. 12AT7 is B9A base, ECC91 is B7G base. Data available. | | | | | |
| 12SG7 GE | £1.65 | £1.10 | £1.10 | £0.80 | £0.70 |
| 85A2* East European 90 day guarantee | £1.80 | £1.20 | £1.20 | £1.20 | £1.10 |
| 300B Billington Gold Special Edition Chinese. *Certain countries have exclusive agents for this item* | £63.00 | £42.00 | £37.50 | - | - |
| 807 Russian | £6.60 | £4.40 | £3.00 | £2.90 | £2.70 |
| 807 Use 5B-254M which has virtually identical characteristics but is on a different base. Data available. FANTASTIC QUALITY, STC UK. | | | | | |
| 829B Use QQV03-20A very similar item on different socket | | | | | |
| 5644 Raytheon | £3.90 | £2.60 | £2.50 | £2.40 | £2.30 |
| 5755 Raytheon USA | POA | POA | POA | POA | POA |
| 5965 GE USA | £0.99 | £0.99 | £0.99 | £0.99 | £0.80 |
| 6028 ECG Philips USA. Possible audio use. 20V heater. Amazing low price – try some for experiments! | £0.99 | £0.66 | £0.66 | £0.60 | £0.55 |
| 6550A refer to 6550B exact equivalent | | | | | |
| 6550B/B3 Russian | £12.00 | £8.00 | £7.00 | £6.00 | £6.00 |
| 7327 Sylvania, may be similar to ECC82 | £1.35 | £1.35 | £0.90 | £0.90 | £0.90 |
| 8203 RCA USA. Can be used in front end of audio pre-amp. Similar to 6CW4. Data available | £4.50 | £3.00 | £3.00 | £2.70 | £2.70 |
| DG7-32 Tungsram CRT (for Marantz tuner 10B) | £14.00 | £14.00 | £13.00 | £12.00 | - |
| E180CC Amperex, Used, guaranteed | £3.00 | £2.00 | £2.00 | £1.80 | £1.60 |
| E180F Mullard UK, gold pin, Mullard logo | £2.93 | £1.95 | £1.95 | £1.85 | £1.75 |
| EAC91 Mullard UK | £1.43 | £0.95 | £0.95 | £0.50 | £0.50 |
| EB91 Mullard UK | £1.50 | £1.50 | £1.00 | £0.95 | £0.75 |
| ECC91 Mullard. Data available. | £1.80 | £1.80 | £1.30 | £1.10 | £0.95 |
| ECL86/6GW8, Try PCL86 which is a similar valve at an amazing low price! Data available | | | | | |
| EF86. Use EF95 which is a similar valve. EF95 is B7G base, EF86 is B9A base. EF95 is recommended in Glass Audio. Data available. | | | | | |
| EF95 Mullard UK | £1.95 | £1.95 | £1.95 | £1.95 | £1.30 |
| EL34 See 3D21 possible alternative | | | | | |
| EL84 near equivalent try 6CH6 | £1.95 | £1.95 | £1.40 | £1.30 | £0.80 |
| 6CH6 Brimar UK, similar to EL84 Mullard but different pin out. *No discounts possible.* Data available | £1.95 | £1.95 | £1.40 | £1.30 | £0.80 |
| EL91* Mullard UK. Audio pentode. Good for low power or headphone amplifier | £3.00 | £2.00 | £1.60 | £1.35 | £1.25 |
| PC86 Zaerix East European | £3.68 | £3.68 | £2.45 | £2.45 | £2.45 |
| PC900/4HA5 East European | £1.72 | £1.72 | £1.15 | £1.15 | £0.90 |
| PCC84/7AN7 Mullard UK | £1.50 | £1.00 | £1.00 | £0.90 | £0.80 |
| PCC89 Russian | £1.50 | £1.00 | £0.90 | £0.75 | £0.65 |
| PCL86/14GW8 Polish or Russian made using Philips technical expertise | £0.53 | £0.53 | £0.53 | £0.53 | £0.37 |
| TT21 Billington Gold Chinese | £27.00 | £18.00 | £18.00 | £16.00 | - |
| UCL82* Russian | £1.80 | £1.20 | £1.20 | £1.10 | £1.00 |
| Socket 4212E (Ref SOC47E) | £25.00 | £19.00 | - | - | - |

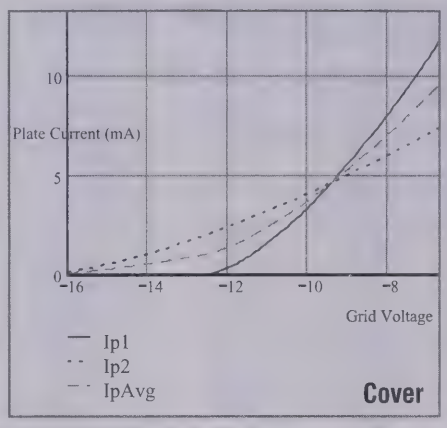
1,000,000 valves in stock including **E88CC, ECC81, ECC82, ECC83, EF86, EL34, EL84, KT66, KT88, 6SL7, 6SN7, 300B, 807, 845, 6080** and **sockets** Please inquire for RETAIL or WHOLESALE prices. We also stock the excellent **BILLINGTON GOLD** brand and limited quantities of **Mullard, GEC**, etc. MASTERCARD, VISA and most credit/debit cards accepted. IE GILLMANS ESTATE · BILLINGSHURST · SUSSEX RH14 9EZ UK.
***Visitors by Appointment only***

**BILLINGTON EXPORT LIMITED**

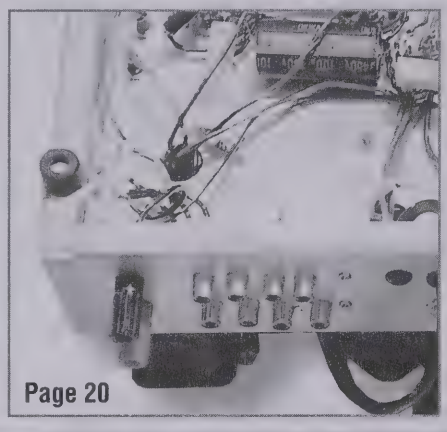
1E GILLMANS TRADING ESTATE • BILLINGSHURST WEST SUSSEX RH14 9EZ UK

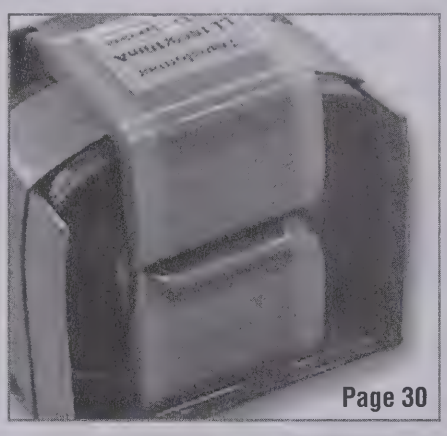
**TEL: (0) 1403 784961 • FAX (0) 1403 783519 • E-mail: sales@bel-tubes.co.uk • Website: Please type Billington Export in your search engine**

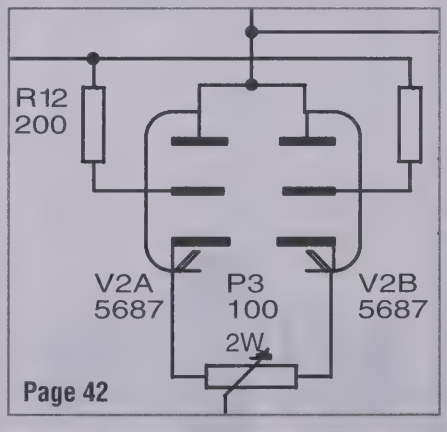
*Reader Service #5*



Cover


Page 20


Page 30



Page 42

# GLASS AUDIO®

**Volume 12** **Number 5** **August 2000**

## FEATURES

**Paralleling Tube Effects** ..... 1
Matt Kamna, Dave McDonald, & Ken Boehlke

**A 20W $260 Amplifier** ..... 20
Joseph Norwood Still

**A Hybrid Amp Revisited** ..... 30
Wim de Haan

**An SE 6AS7G Design** ..... 42
George J. David

## PRODUCT REVIEWS

**AE-25 Super Amp** ..... 33
Reviewed by Charles Hansen

**Critique** ..... 35
Ken & Julie Ketler

**Kirksaeter's SL-60** ..... 36
Reviewed by Joseph D'Appolito

**Critique** ..... 38
Rita & Dennis Colin

**Wheatfield Audio HA-2 Headphone Amp** ..... 39
Reviewed by Charles Hansen

**Critique** ..... 41
Betty Jane & Richard Honeycutt

**2A3 Sovteks** ..... 46
Reviewed by Charles Hansen

## DEPARTMENTS

**PUBLISHER'S ANNOUNCEMENT** ..... 6

**BOOK REVIEW** ..... 66
***Valve Amplifiers***
Reviewed by Larry Lisle

**GLASS SHARD** ..... 70
**A Rozenblit Preamp**
By Fred Slaven

**LETTERS** ..... 50

## IN EVERY ISSUE

**GLASSIFIEDS** ..... 64

**AD INDEX** ..... 64

**YARD SALE** ..... 65

**WEBSITE RESOURCES** ..... 68

# Look Here!!

*We are here to help you find what you look for*
*Click http://www.netspace.or.jp/~eifl/eifl/export/export2.htm for more products information*

## ■Cartridge

| Model | Price (US $) | Postage (Air Economy) |
|---|---|---|
| Denon DL-102 (MONO) | 150 | Area I $18: China, Korea, Hong Kong, Taiwan |
| Denon DL-103 (STEREO) | 200 | Area II $22: Singapore, Malaysia, Indonesia |
| Denon DL-103R (STEREO) | 250 | Area III $27: North America, Oceania, Europe |
| Shelter Model 501 II (Crown Jewel) | 650 | Area IV $34: Africa, South America |
| Ortofon SPU Classic GE | 630 | |

These Area I ~ IV are for all products except book.

## ■Japanease Audio Book

Postage $15

| Title | | Price(US $) |
|---|---|---|
| Attractive Tube Amps Vol. 1&2 | (Isamu Asano) | 30 each |
| Top-Sounding Vintage Power Tubes | (Stereo Sound) | 30 |
| MJ Selected 300B Amps | (MJ) | 30 |
| Audio Tubes | (Hisashi Ohtsuka) | 35 |
| SE Amps by Transmitting Tubes | (Kouichi Shishido) | 50 |
| Classic Valve | (Hisashi Ohtsuka) | 40 |
| Vintage Radios | (Tatsuya Taguchi) | 40 |
| The Remembrance of Sound Post | (Susumu Sakuma) | 30 |
| Tube Amp Craft Guide | (MJ) | 30 |
| FOSTEX CRAFT HAND BOOK | (FOSTEX) | 20 |

## ■Speaker

| Model | Specifications | | | | | Price* | Postage** (US $) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | D(cm) | Ω | Response | db | w | (US $) | I | II | III | IV |
| Fostex FE208 Σ | 20 | 8 | 45Hz~20kHz | 96.5 | 100 | 296 | 62 | 74 | 120 | 156 |
| Fostex FE168 Σ | 16 | 8 | 60Hz~20kHz | 94 | 80 | 236 | 42 | 50 | 73 | 98 |
| Fostex FE108 Σ | 10 | 8 | 80Hz~18kHz | 92 | 15 | 144 | 30 | 36 | 50 | 66 |
| Onken OS5000T | — | 8 | 7kHz~25kHz | 105 | 2.5 | 4,000 | 70 | 84 | 133 | 181 |
| GOTO SG-160 | — | 8 | 4kHz~30kHz | 110 | 5 | 4,400 | 75 | 90 | 140 | 191 |

*Price is for a pair **Air Economy

## ■STAX

| Model | Price(US $) |
|---|---|
| OMEGA II System(SR-007+SRM-007t) | Ask |
| SRS-5050 System W MK II | |
| SRS-4040 Signature System II | |
| SRS-3030 Classic System II | |
| SRS-2020 Basic System II | |
| SR-001 MK2(S-001 MK II+SRM-001) | |

## ■Transformer

| Model(SE OPT) | Specifications | | | | Price* | Postage** (US $) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | W | Pri.Imp(kΩ) | Freq Response | Application | (US $) | I | II | III | IV |
| Tango XE-60-5SNF | 30 | 5 | 25Hz~70kHz | 300B, 50, PX-25 | 612 | 62 | 74 | 115 | 156 |
| Tango XE-20S | 20 | 2.5, 3.5, 5 | 20Hz~90kHz | 300B, 50, 2A3 | 384 | 47 | 56 | 84 | 113 |
| Tango FW-150-10SR | 40 | 10 | 25Hz~35kHz | 211, VT-4C | 940 | 76 | 92 | 147 | 201 |
| Tango NY-15-3.5S (45% Permalloy) | 15 | 3.5 | 20Hz~45kHz | 300B, 50 2A3 | 876 | 62 | 74 | 115 | 156 |
| Tango U-808 | 25 | 2, 2.5, 3.5, 5 | 20Hz~65kHz | 6L6, 50, 2A3 | 238 | 42 | 50 | 73 | 98 |
| Tango X-5S | 40 | 5 | 18Hz~70kHz | 50, 845 | 1074 | 79 | 96 | 154 | 211 |
| Tamura F-7001 (Permalloy) | 8 | 3 | 15Hz~60kHz | 300B,2A3 | 650 | 70 | 84 | 133 | 181 |
| Tamura F-7003 (Permalloy) | 10 | 5 | 15Hz~50kHz | 300B,50 | 760 | 70 | 84 | 133 | 181 |
| Tamura F-2013 | 40 | 10 | 20Hz~50kHz | 211,VT-4C | 730 | 70 | 84 | 133 | 181 |

*Price is for a pair. ** Air Economy

E-I-F-L EIFL Corporation

22-32, Fujimi 2-chome, Sayama City, Saitama Pref. 350-1306 JAPAN.
Phone:+81-(0)42-956-1178 FAX:+81-(0)42-950-1667
E-mail:eiflcorp@netspace.or.jp
Wire Transfer:DAIICHIKANGYO BANK, SWIFT No.DKBLJPJT a/c # 294-9100866

VISA MasterCard

Reader Service #100

*(from page 1)*

## GROUNDWORK

We discussed among ourselves whether the transfer curves of parallel tubes might add to form a ripple. If this were true, you would expect to measure unpleasant high-order harmonics. The most widely known "ripple" effect is crossover notch distortion in early transistor amps.

To answer these questions, we had available to us a variety of frequency and time-domain equipment, and determined that certain tests would be able to verify proper tube operation as well as the pattern of harmonics.

We needed to select a tube candidate. The 6SN7 was a logical choice because it is a very common tube and is accepted as a linear device. Fortunately, we had a large number of them on hand to test—20 used and 10 new tubes from five different manufacturers.

We chose the single common-cathode triode circuit for simplicity and for how the tube is most often used. Paralleled triode combinations were made by wiring directly from cathode-to-cathode and plate-to-plate. This configuration uses less parts and is common practice.

We referred to a tube manual for Class A1 operating characteristics of the 6SN7. For measurement convenience, we chose 244V across the tube, 8V bias, and 8mA of plate current. This point is just slightly under the more typical upper operating condition given.

We considered several tube characteristics. It is desirable to test many tubes to help prevent statistical error. In order to reduce the total data, we narrowed down the measured characteristics to three. We thought that verification of DC plate current, voltage and AC gain would cull out any bad tubes. Interestingly, none were rejected for being vastly different from the rest, thus indicating to us that the used tubes still had plenty of life left. The third item of interest was to record all the levels of the first six harmonics.

## MEASUREMENTS

We gathered over 600 pieces of data, with each tube warmed up in a special two-tube test fixture before measuring. While one tube was warming up, we measured the already warm tube.

By properly calculating the plate load resistor, B+, and cathode resistor values, it was possible to self-bias good tubes near the tube manual operating points. All resistors were very carefully matched. Each 1.00kΩ cathode resistor was bypassed with a 47µF capacitor, which is about 4Ω of impedance at the 1kHz test frequency. Filament and B+ voltages were precisely set on regulated supplies. This put all sections of both tubes in equal operating conditions.

All four 100Ω grid-stopper resistors were fed from a 50Ω generator. Grid-loading effects were minimized by using a low impedance generator. Plate-load resistors chosen were 25kΩ, approximately three times the tubes' plate resistance.

A three-position toggle switch connected the grid to either a 10kΩ resistor to ground, a 1V RMS sine wave, or the other large low-distortion AC signal source. The 10kΩ resistor was used during the measurement of the DC operating point. We chose a 1V RMS signal so that the plate output signal in RMS volts would equal that particular tube section's gain. To reduce measurement time and prevent error, we used two generators, which allowed each to remain at its fixed output level during all the tests. Two four-position rotary switches were used for selecting which one of the four plates and cathodes to connect the measurement probes to, thereby eliminating the need to continually move the test probes.

Measuring equipment included a 3½ digit DMM, 5½ digit DMM, and a wide dynamic-range spectrum analyzer. By paralleling two sections, the amplifier output impedance reduces to half that of a single section. This reduces the proportional loading from the DMM and spectrum analyzer on the circuit. The high-impedance inputs of the 5½ digit DMM and spectrum analyzer X10 probe caused only a slight gain change of less than 2% from a single tube section to parallel operation.

Circuit values were chosen so that it was necessary to measure only the cathode voltage. A 1.00kΩ cathode resistor gives a voltage readout equal to the cathode current in milliamps (1V/mA). The B+ and plate-load resistors were set so that the other DC tube parameters would fall into place if the cathode current was correct. Since extremely little grid current is drawn, the plate current is essentially equal to the cathode current.

## OUTPUT HARMONIC LEVELS

Once we measured the DC operating point and AC gain of the tube and verified proper tube operation, we selected a drive level which provided fourth harmonics that were out of the spectrum analyzer's noise floor on most tubes. This gave an output level of approximately 40V RMS.

After the primary data collecting of individual tube sections, a preliminary analysis calculated such information as data spread. *Table 1* shows the range of differences between 60 triode sections. Probably the most notable is the large 24.2dB variation in the third harmonic level.

Next, matches and mismatches were sought out. Once again, the categories are DC quiescent current, AC gain, and harmonics. The idea was to find both the best and worst match candidates for the actual parallel tests. We found single, double, and triple matches and mismatches.

We considered that an output level greater than 40V RMS might give different results, so repeated the test at 80V RMS out! This signal level was still less than that which would cause either grid current or cutoff. Some of the data is shown in *Tables 2* and *3*.

The data shows that for matched paralleled sections the distortion is essentially the average of the individual sections. In some cases, the distortion was actually slightly lower in parallel mode. This is thought to be caused by the halving of the output impedance driving the test equipment's capacitive inputs.

Mismatched paralleled sections were unpredictable. Some of the harmonics levels of the paralleled tubes were worse and some were better than the best section in each pairing. We expected to see some new high-order harmonics show up, but instead were surprised with these results.

For harmonics that were about 85dBc and lower, there was some variability in the results. This was due to the addition or cancellation of Gaussian noise and the low-level harmonic being measured.


### ABOUT THE AUTHORS

Matt Kamna has been an engineering assistant in the electronics industry for over 20 years. He was trained by some of the best engineers at Tektronix. He loves music of all "flavors," when done right, but '60s and '70s rock-n-roll seems to match his natural body response frequency best.

Dave McDonald is a vacuum tube audio enthusiast. He likes jazz, classical, and many other forms of music. A member of the Oregon Triode Society for the past 20 years, he has been involved in the manufacturing, engineering, marketing, and measurement applications of spectrum analyzers at Tektronix.

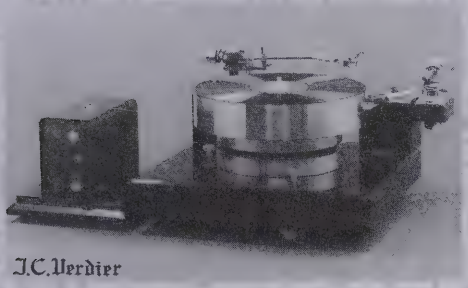
Kenneth A. Buchlke is the leader of the ASIC system design group and Focus Enhancements, Inc. of Hillsboro, Oregon. Following graduation from the University of Idaho in 1982, he has worked in the last 20 years designing mixed analog and digital systems with an emphasis in digital signal processing. Using his math background, he supplied the theoretical portion of this article.

# APEX

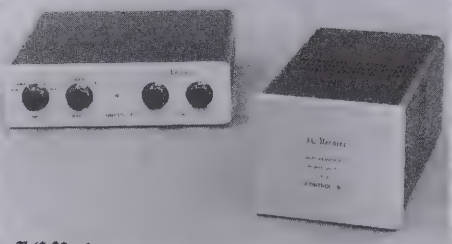
## FINALLY A TRUE REFERENCE SYSTEM

WAS THE STATEMENT HEARD IN OUR CROWDED SUITE DURING THE CES IN LAS VEGAS. PROFESSIONALS INCLUDING THE MEDIA FROM DIFFERENT COUNTRIES ALWAYS REFERRED TO OUR SOUND AS BEING SO REAL AND EFFORTLESS. MANY CAME BACK BRINGING MORE PEOPLE AND THE COMMENTS WERE THE SAME : "ONE OF THE BEST - ONE OF THE BEST IF NOT THE BEST - THE BEST"

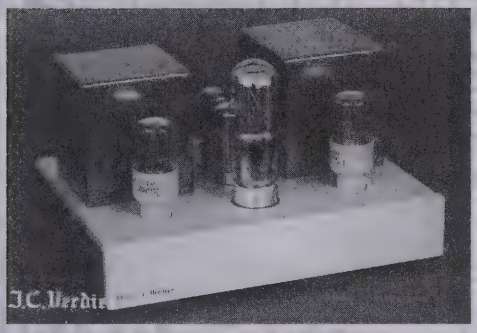
AT APEX, IMPORTER & DISTRIBUTOR OF J.C. VERDIER, MODERN TECHNOLOGY HAS ALWAYS BEEN A TOOL RATHER THAN AN END. WE BELIEVE THAT WE OWE COMPOSERS, MUSICIANS AND SINGERS, PAST AND PRESENT, THE RIGHT TO DELIVER AS FAITHFULLY AS POSSIBLE THE PASSION OF THEIR MUSIC.



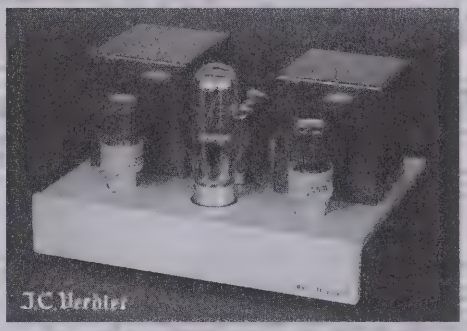

LA PLATINE VERDIER



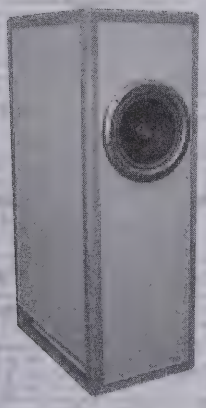

CONTROL "B" DUAL REGULATED POWER SUPPLY




845 TRIODE SPIRIT




845 TRIODE SPIRIT



ACOUSTIQUE ET LUTHERIE

OCELLIA KEDROS WITH PHY-HP DRIVERS AND CABLES

ACOUSTIQUE ET LUTHERIE

OCELLIA KEDROS WITH PHY-HP DRIVERS AND CABLES

APEX: 677, OLIVE AVENUE, NOVATO, CA 94945 USA - TEL/FAX 00.1.415.897.5616
WWW.2000APEX.COM

MANUFACTURER: J.C. VERDIER: 5/7, RUE D'ORMESSON
PHONE: 00 (33) 1 48 41 89 74
FAX: 00 (33) 1 48 41 69 28
WEBSITE: JCVERDIER.COM

TURNTABLE AND VACUUM TUBES AMPLIFIERS

Reader Service #55

**TABLE 1**

**INDIVIDUAL TUBE SECTION DATA**

| | DC IP (MA) | AC AV | HARMONICS (DBC) AT APPROXIMATELY 40V RMS OUT 2ND | 3RD | 4TH | 5TH |
|---|---|---|---|---|---|---|
| Minimum | 7.38 | 14.48 | 39.5 | 78.7 | | |
| Maximum | 8.26 | 17.25 | 31.8 | 54.5 | 77.5 | 80.3 |
| Delta | 12% | 1.5dB | 7.7dB | 24.2dB | >12.5dB | >10dB |

Measurements below 90dBc would require extremely long measurement times, so we left these values blank.

*Table 4* points out what can happen if there is only a small DC mismatch (12% 1.14mA) between tubes; 13A now hogs more than twice the current of 2A, and 2A's not very happy as its rp and gm are rapidly approaching 50% of the other tube it's joined with. This would suggest that for common bias circuits the sections should be at least tested for DC matching before paralleling.

**TABLE 2**

**MATCHED PARALLEL SECTIONS**

| TUBE # & SECTION | DC IP (MA) | AC AV | HARMONICS (DBC) 2ND | 3RD | 4TH | 5TH | 6TH | 7TH | MATCHED FOR |
|---|---|---|---|---|---|---|---|---|---|
| MATCHES AT APPROXIMATELY 40V RMS OUT | | | | | | | | | |
| 5A | 7.60 | 16.21 | 37.0 | 60.5 | | | | | DC plate |
| 5B | 7.59 | 16.28 | 37.4 | 62.2 | | | | | current & |
| Parallel | 15.18 | 16.31 | 37.3 | 61.5 | | | | | AC gain & Harmonics |
| 8A | 7.84 | 17.06 | 34.5 | 57.9 | 84.5 | | | | Harmonics |
| 8B | 7.76 | 16.93 | 34.7 | 58.1 | 80.8 | | | | |
| Parallel | 15.62 | 17.05 | 34.7 | 58.2 | 83.5 | | | | |
| 10A | 8.02 | 14.78 | 39.4 | 68.7 | 82.5 | | | | AC gain & |
| 10B | 7.83 | 14.76 | 38.9 | 69.3 | 83.5 | | | | Harmonics |
| Parallel | 15.86 | 14.82 | 39.3 | 69.2 | 83.7 | | | | |
| MATCHES AT APPROXIMATELY 80V RMS OUT | | | | | | | | | |
| 5A | | | 30.7 | 49.4 | 68.8 | | 87.7 | | DC plate |
| 5B | | | 30.8 | 49.0 | 65.3 | 80.8 | 85.0 | | current & |
| Parallel | | | 31.0 | 49.4 | 67.4 | 87.0 | 86.7 | | AC gain & Harmonics |
| 8A | | | 28.1 | 46.1 | 68.8 | 88.0 | | | Harmonics |
| 8B | | | 28.4 | 46.7 | 71.0 | 84.5 | | | |
| Parallel | | | 28.4 | 46.6 | 70.3 | 85.5 | | | |
| 10A | | | 33.6 | 56.6 | 85.2 | | 82.5 | | AC gain & |
| 10B | | | 33.1 | 56.3 | | 86.6 | 83.7 | | Harmonics |
| Parallel | | | 33.4 | 56.7 | 87.6 | | 84.5 | | |

**TABLE 3**

**MISMATCHED PARALLEL SECTIONS**

| TUBE # & SECTION | DC IP (MA) | AC AV | HARMONICS (DBC) 2ND | 3RD | 4TH | 5TH | 6TH | 7TH | MISMATCHES IN |
|---|---|---|---|---|---|---|---|---|---|
| MISMATCHES AT APPROXIMATELY 40V RMS OUT | | | | | | | | | |
| 13A | 8.24 | 15.11 | 39.1 | 77.4 | 88.0 | | | | DC plate |
| 2A | 7.36 | 16.53 | 36.9 | 66.0 | 88.0 | 88.0 | | | current |
| Parallel | 15.72 | 15.65 | 37.1 | 64.6 | 83.1 | 90.0 | | | |
| 7A | 8.06 | 14.55 | 38.3 | 73.8 | 89.0 | 89.0 | | | AC gain |
| 24A | 7.73 | 17.33 | 33.3 | 57.3 | 89.0 | | | | |
| Parallel | 15.78 | 15.89 | 34.0 | 60.5 | 85.0 | | | | |
| 17A | 8.25 | 14.73 | 31.9 | 54.8 | 83.8 | 83.5 | | | Harmonics |
| 10A | 8.02 | 14.76 | 39.4 | 68.5 | 83.0 | | | | |
| Parallel | 16.30 | 14.86 | 35.1 | 60.4 | 88.0 | | | | |
| MISMATCHES AT APPROXIMATELY 80V RMS OUT | | | | | | | | | |
| 13A | | | 32.4 | 57.3 | 74.4 | 77.1 | 85.5 | 85.5 | DC plate |
| 2A | | | 29.7 | 48.6 | 64.3 | 71.9 | 86.4 | 87.0 | current |
| Parallel | | | 30.1 | 50.4 | 68.1 | 82.2 | | | |
| 7A | | | 31.8 | 56.0 | 84.5 | 78.0 | 86.0 | | AC gain |
| 24A | | | 26.4 | 44.1 | 68.9 | 89.0 | 89.0 | | |
| Parallel | | | 27.5 | 47.9 | 74.2 | 82.7 | 84.3 | | |
| 17A | | | 25.1 | 45.1 | 63.5 | 64.4 | 85.0 | 75.3 | Harmonics |
| 10A | | | 32.3 | 53.6 | 75.9 | 85.0 | 85.0 | | |
| Parallel | | | 28.0 | 48.5 | 79.8 | 73.4 | | 83.0 | |

## LISTENING TESTS

Just the data alone was not satisfying enough, so we decided to do listening tests, which might reveal something that simple measurements could not. Many ideas were conceived and evaluated on paper. The research stalled for many months while we struggled to come up with a valid listening test fixture and a reasonable test setup.

The listening fixture consisted of a two-stage 300B stereo power amplifier. The input circuit was a self-biased Svetlana 6N1P dual triode. A 1:1 SE Lundahl interstage transformer coupled the input tube to a battery-biased SV300B. The output tube drove a 4.8kΩ One Electron™ UBT-2 output transformer. It is important to note that the gains of the two channels were adjusted to be closely matched.

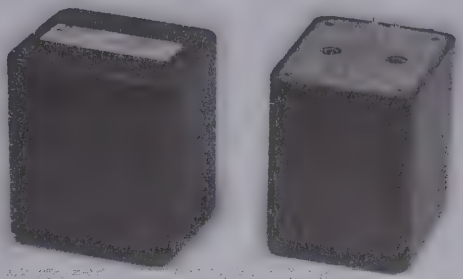
The amplifier was modified with two relays inside the chassis to accommodate parallel operation. One relay's contacts were connected between the plates of the input tube. The other relay's contacts joined the plates of the 300B output tubes together.

Two toggle switches controlled the relays by applying 5V DC from the filament supply to the relay coils. In this way the signal leads were kept very short. Only 5V DC would be on the 8′ control wires leading to the toggle switches located at the listening position.

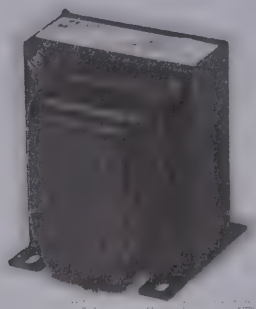
There were four combinations of switch settings: isolated channels, parallel input plates only, parallel output plates only, and both input tube and output tube plates paralleled respectively. All listening tests were done in dual mono. One channel of a stereo CD player was applied to both left and right inputs of the test amplifier. The 4Ω left and right outputs were connected to their respective speakers.

Listening tests involved three systems in separate locations. Many different listeners participated in the sonic evaluation. Attempts were made to hear the difference between parallel and non-parallel configuration. A majority of the listeners were hard-pressed to hear any difference. One listener heard very subtle differences and tried hard to determine which setting was preferable.

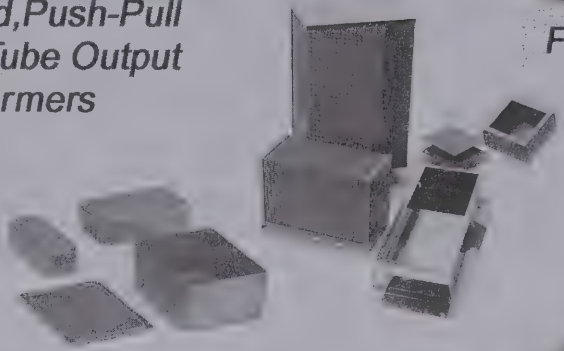
# Purveyors of "Classic" Transformers & Enclosures



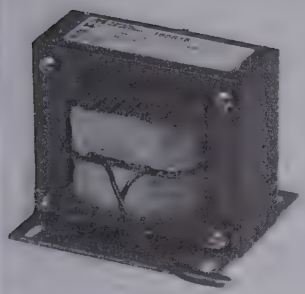
*Single Ended,Push-Pull and Potted Tube Output Transformers*



*Filter Chokes*



*Aluminum & Steel Chassis and Diecast Aluminum Enclosures*



*Open & Enclosed Filament Transformers*

*High Voltage Plate Transformers*

*Contact us for a free catalog & list of stocking distributors*

HAMMOND MANUFACTURING™

256 Sonwil Dr. - Cheektowaga, NY 14225 USA
Phone: (716) 651-0086 Fax: (716) 651-0726
394 Edinburgh Rd., N. - Guelph, Ontario N1H 1E5 Canada
Phone: (519) 822-2960 Fax: (519) 822-0715
***www.hammondmfg.com***

**TABLE 4**

**COMMON VERSUS INDEPENDENT BIAS**

| | INDEPENDENT BIAS | | COMMON BIAS (PARALLEL) | |
|---|---|---|---|---|
| TUBE # & SECTION | 2A | 13A | 2A | 13A |
| Voltage across tube | 260V | 237V | 247V | 247V |
| Plate voltage | 267V | 245V | 255V | 255V |
| Cathode voltage | 7.36V | 8.25V | 7.86V | 7.86V |
| Cathode current | 7.36mA | 8.25mA | 4.98mA | 10.77mA |

## COMPUTER ANALYSIS

At this point we wondered why people had often stated that parallel stages did not sound good. Perhaps other paralleled circuits had poor parts matching, improper design, or implementation.

We hoped that mathematics could explain what would happen in a parallel circuit, so we discussed our measurement and listening test results with another associate whose math capabilities exceeded ours. Our desire was to derive the mathematical formulas and, using them for graphical analysis, show where parallel operation would work or where it might have problems.

We started with a formula for triodes relating plate current versus grid voltage, plate voltage, and mu from *Radio Engineering* by Terman.

From this, using MathSoft's Mathcad™ software, we produced curves for triodes, as well as the resulting curve from paralleling a pair of dissimilar triode curves. Different triode parameters were varied to study their effects on parallel operation. The results of varied parameter combinations were similar. Representative curves are shown in *Fig. 1*.

Note that the current of each tube was divided by two before being added so that the resultant third curve would fall within the graph range to allow for easy visual interpretation of parallel effects. It is important to note that the graph is true for the case where grid-to-cathode/filament bias voltages are equal for the two tubes.

The effect of different cutoff voltages for two paralleled tubes causes an abrupt change in linearity. For example, in *Fig. 1* this happens at about –12.5V, where one tube cuts off. One way to deal with this problem is to use a curve tracer to match the cutoff voltages.

## FURTHER ANALYSIS

Although it does not appear on the graph, there is another effect. At the opposite end of cutoff the signal swing can cause another problem in paralleling tubes. If they do not have equal grid bias, then one tube will draw grid current earlier than the other one. In an output stage this would reduce the maximum linear power out that could otherwise be obtained. Be-

*to page 58*

**TABLE 5**

$Ip = K(Eg + (Ep/\mu))^{3/2}$

$y = x^{3/2}$

$y^{I} = (3/2)x^{1/2}$

$y^{II} = (3/4)x^{-1/2}$

$y^{III} = (-3/8)x^{-3/2}$

$y^{IV} = (9/16)x^{-5/2}$

$y^{V} = (-45/32)x^{-7/2}$

$y^{VI} = (315/64)x^{-9/2}$

$y^{VII} = (2835/128)x^{-11/2}$

Taylor Series $f(x) = f(a) + (x-a)f'(a) + ((x-a)^2/2!)f''(a) +\ldots + ((x-a)^n/n!)f^{(n)}(a)$

$\Delta f(x) = \Delta x f'(a) + (\Delta x^2/2!)f''(a) +\ldots + (\Delta x/n!)f^{(n)}(a)$

| | |
|---|---|
| $i_p = eg \times (3/2)K(Eg + (Ep/\mu))^{1/2}$ | fundamental |
| $+ eg^2 \times (3/4)K(Eg + (Ep/\mu))^{-1/2}$ | 2nd harmonic |
| $-eg^3 \times (3/8)K(Eg + (Ep/\mu))^{-3/2}$ | 3rd harmonic |
| $+ eg^4 \times (9/16)K(Eg + (Ep/\mu))^{-5/2}$ | 4th harmonic |
| $-eg^5 \times (45/32)K(Eg + (Ep/\mu))^{-7/2}$ | 5th harmonic |
| $+ eg^6 \times (315/64)K(Eg + (Ep/\mu))^{-9/2}$ | 6th harmonic |
| $-eg^7 \times (2835/128)K(Eg + (Ep/\mu))^{-11/2}$ | 7th harmonic |


# Find Audio Excellence!

## in each issue of *audioXpress*

Continuing *Glass Audio, Audio Electronics*, and *Speaker Builder.*

audio PRESS
IT JUST SOUNDS BETTER
Continuing Audio Electronics, Glass Audio & Speaker Builder
A 30W Monoblock Amplifier
Fitzmaurice Builds A Double Reverse Horn
Tilting System Response With Tubes
Class D Amps For Subwoofers
Do Harmonic Distortion Measurements Mean ANYTHING?
Constructing A Super Ribbon Speaker
AN OVERFLOWING EQUIPMENT REVIEWS SECTION!

- More projects
- More Articles
- More reviews
- More issues (*now monthly!*)

Every issue is packed with information about tube audio...whether you're looking for the next great tube preamp project, where to buy a tube preamp for your home theater, or an introduction to how tubes work with Audio Classroom, you'll find it in each issue of **audioXpress**.

You'll also find information on speakers – the best value, how to build them, where to find them... and what's really happening to make the digital audio world more listener-friendly.

Call: 888-924-9465 or E-mail: custserv@audioXpress.com.
Only $29.95 for 12 great monthly issues.

CANADA ADD $12 PER YEAR – OVERSEAS RATE $59.95 PER YEAR.

***audioXpress***, PO Box 876 Dept. G0, Peterborough, NH 03458-0876 USA 888-924-9465 or 603-924-9464
Fax: 603-924-9467 E-mail: custserv@audioXpress.com Web: **www.audioXpress.com**

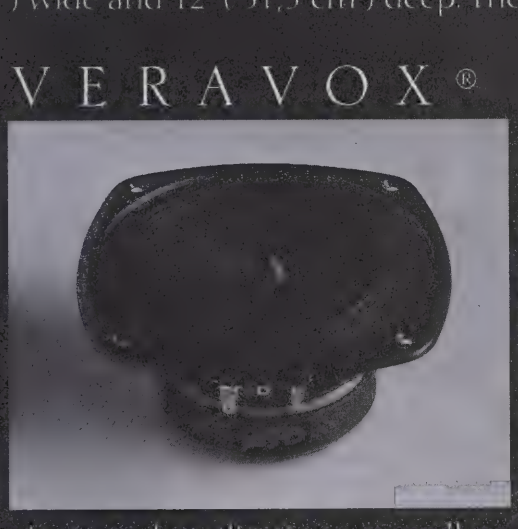
# ARE YOUR SPEAKERS TUBE FRIENDLY?

ATD has developped the "Aureavox" range of speaker systems and the "Veravox" range of drive units, both particularly suited technically and sonically to match tube amplifiers :

## AUREAVOX®

The Aureavox "O" is a high quality compact two-way loudspeaker system, designed with low-power, low-damping-factor tube amplification in mind. Our main design goal objectives are high sensitivity with a clear, wide-open sound quality; an acoustic window on the Music.To achieve this, Aureavox has chosen to combine some pretty radical engineering solutions. Using today's state-of-the-art R & D equipment we have carefully & critically analysed all cone materials past and present, and have settled on a unique vintage-based pulped paper fibre material. For the six-and-a-half inch main unit, the cone is moulded into a "Hypex" profile, and offers near to full range capabilities. A critically damped, pleated fabric surround was chosen to avoid the mass and hysteresis of the more usual "slow" rubber surrounds. Our high frequency treble unit was developed at the same time, and is totally complementary in its design. A one-and-three-quarters inch paper pulped cone. The use of a more common "dome" tweeter was ruled out. Our use of a cone avoids the main problem a dome tweeter exhibits, and gives us a natural control of its dispersion. Both units are fitted with "phase plugs" at the centre of the cone to help optimise the radiation & dispersion elements. Due to the very similar characteristics of both units, the crossover is relatively uncomplicated, with the absolute minimum number of components, of the absolute best sonic qualities. The compact cabinet measures just under 17" ( 43 cm ) tall by 9" ( 23,5 cm ) wide and 12" ( 31,5 cm ) deep. The cabinet is hand finished in handsome solid walnut.

## VERAVOX®



The "Veravox" family of 5" and 7" drive units has been optimised for use with tube amplifiers, with a special attention to triodes. The "Veravox" series uses exclusively classic cellulose fibre cones ( with the traditional European blend of materials ). The "Hypex" cone profile has been derived from ORTF vintage monitoring drive units of the 50's and 60's. The surrounds are either integrated pleated paper or pleated textile, damped with specific viscoloid compounds. The "Veravox" drive units are available in different versions, from full-range units to mid-woofers ( not forgetting dedicated midranges ). The TS parameters are thought for classic ported applications as well as more exotic TQWT and Horn loadings. Dedicated kit applications are available.

ATD sas, Via Tortona 31 int. 26, 20144 Milano, Italy;
Fax: +39-02-477 155 39, Tel: +39-02-48 95 07 81, E-mail : atd@iol.it

Reader Service #32

*Get your copy of the*

# THE PARTS CONNECTION CATALOG

# THE DEFINITIVE PARTS SOURCE

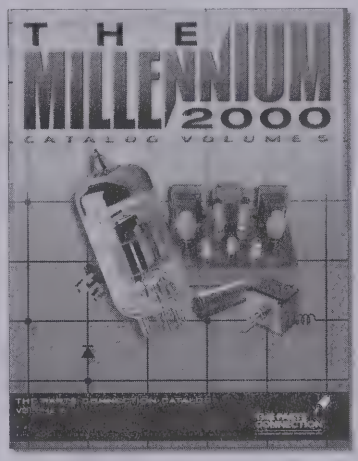
## VOLUME 5 & BREADBOARD SUPPLEMENT

## The BreadBoard Latest Edition

The Parts Connection's FREE Bulletin for News, Specials, Overstock & Clearance Items! This issue features "Specially Priced" items from InfiniCap, Nichicon, ALPS, Noble and many many more. Nearly 1200 different parts in all. Prices discounted from 25% to 80%! Download a copy of the April 2000 edition of the BreadBoard from **www.partsconnection.on.ca** and then click on BREADBOARD button.

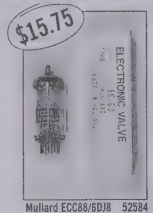
**THE PARTS CONNECTION'S CATALOG** - Volume 5 will be available in September packed with our regular selection of high quality component parts, tubes, wire and cable, connectors, dozens of audio related construction and design books, capacitors, resistors and more. As well, we have an updated product line-up on 100 + pages. To download the FREE copy of The Parts Connection's Catalog Vol. 5 go to our Web site's main home page at: **www.partsconnection.on.ca** and then click on CATALOGUE button.

NEW LOWER PRICES ON MOST ITEMS

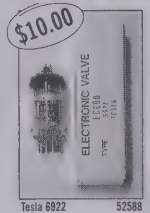



## NEW-OLD-STOCK TUBES!

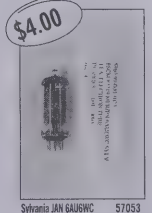
Valvo ECC88/6DJ8 52585
Dual Triode In Valvo-Hamburg Box, Germany '62 /'63



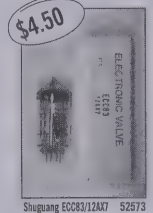

Mullard ECC88/6DJ8 52584
Dual Triode, Old Logo, White Box, Holland



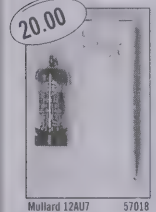

Tesla 6922 52588
Dual Triode - white box, Czech



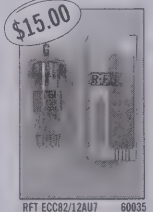

Sylvania JAN 6AU6WC 57053
Sharp Cutoff Pentode, U.S.A



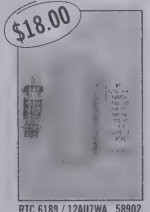

Shuguang ECC83/12AX7 52573
Dual Triode, Gold Dragon Type, China



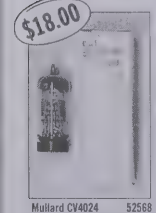

Mullard 12AU7 57018
CV4003/M8136
A 'super' 12AU7 to Military Spec, U.K



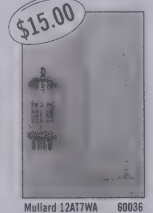

RFT ECC82/12AU7 60035
East Germany, Original Box



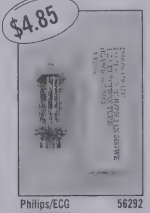

RTC 6189 / 12AU7WA 58902
Medium Mu Dual Triode, France 1962 vintage




Mullard CV4024 52568
Old Logo - Dual Triode, Mil Spec, U.K M8162 / 12AT7WA, King of the 12AX7's



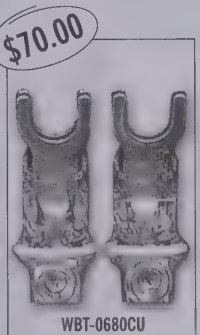

Mullard 12AT7WA 60036
New logo - Dual Triode, Mil Spec U.K., Same as M8162 / CV4024




Philips/ECG 56292
JAN 5687WB
Dua. Triode

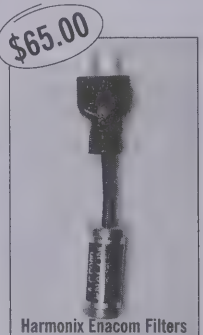
Mullard GZ33
60152

**Mullard GZ33/60152**
5 volt Dual Rectifier, slow turn on
- To Military Spec's
- U.K. Sub for 5AR4/GZ34 and CV378/GZ37
- Plate voltage 500 V Max




WBT-0680CU
60136

**WBT Sandwich Spade**
- Silver plating over copper
- Angled for easy installation




Harmonix Enacom Filters
60153

**Harmonix Enacom**
Your defence against noise pollution

Valve Art 2A3
60126

**Valve Art 2A3**
Great value with superb sound characteristics

**Black Gate**
- The line has been extended.
- 50 more valves have been added.

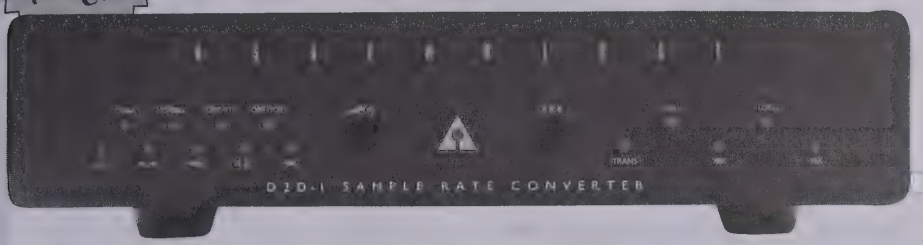
**BG-N:** High performance power supply, best for self-bias of tube amps, Best for CD high quality.
**BG-NX:** For ultra high frequency.
**BG-WKZ:** The champion for Vacume Tubes Amplifiers.
**BG-NH:** Excellent capability for high power sing driver.
**BG-VK:** Comparable to high performance film capacitors.

# The Parts Connection - The Audio Hobbyist's Definitive Parts Source

ASSEMBLAGE

NEW ONLY $699 USD*

## ASSEMBLAGE D2D-1 SAMPLE RATE CONVERTER

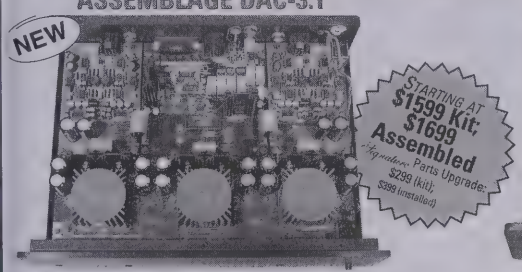



- ***Up-samples*** from as low as 32 kHz to 96 kHz,
- ***Interpolates*** Word Lengths from 16-bit to 24-bit,
- State-of-the-Art ***Jitter Attenuator*** - Begins at 10 Hz with Intrinsic Jitter less than 2ps (pico-seconds),
- ***Digital Transmission Format Converter*** - 5 Digital Inputs (4-S/PDIF; 1-AES/EBU) into 5 concurrent Digital Outputs (2-S/PDIF; AES/EBU; I²S (Audio Alchemy type); and I²S•*enhanced*).

* Buy our ASSEMBLAGE D2D-1 Sample Rate Converter and **SAVE $100** on the purchase of either our ASSEMBLAGE DAC-2.7 or DAC-3.1 **ORDER NOW!**

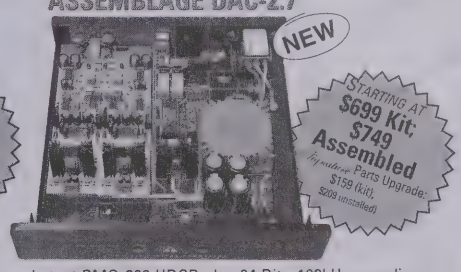
## 24 BIT IN A KIT!

### ASSEMBLAGE DAC-3.1



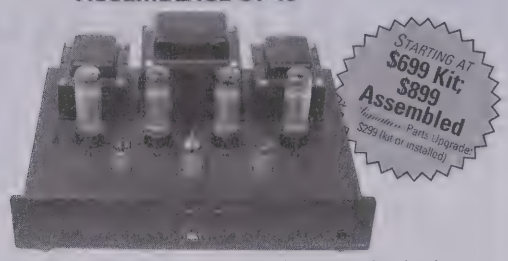

- Latest PMO-200 HDCD plus 24 Bit - 192kHz sampling rate capability, with 24 Bit DAC resolution.
- Ultra-low jitter dual-PLL input circuitry (<2ps).
- 6 inputs - I²S, AES/EBU (XLR), S/PDIF (RCA/BNC Coax), ST & Toslink Optical-Selected manually or automatically.
- Fully Balanced and Unbalanced high drive OPA627A and BUF634 O/P stages.
- Digital I/P transformer isolation on all the wired digital signal inputs; 9 pulse transformers in total.
- ISO-150 Digital Couplers for Digital and Analog PCB Isolation.
- Three toroidal transformers on separate P/S PCB with 21 power supply regulator stages.
- Three 4 layer PCBs with both SMT and thru-hole components plus 1 two layer PCB.
- Upgrade kits available: OPA627's, HEXfred, Caddock, Oscon, Kimber, Ohm-aha, etc...

### ASSEMBLAGE DAC-2.7



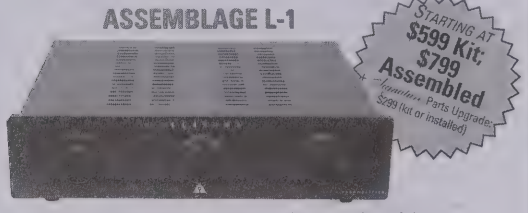

- Latest PMO-200 HDCD plus 24 Bit - 192kHz sampling rate capability, with 24 Bit DAC resolution.
- 4 inputs - AES/EBU (XLR), S/PDIF (RCA/BNC Coax, Toslink Optical)
- Potted and encapsulated toroidal transformer; two low jitter Digital input pulse transformers, low ESR/ESL filter capacitors; ultra-fast, soft recovery diodes; 4 adjustable and 7 fixed regulated P/S stages.
- 4 layer PCB with both SMT and thru-hole components.
- Analog Devices OPA604 op amp added as DC offset servo for I/V stage.
- 4 layer PCB with both SMT and thru-hole components.
- Upgrade Kits available: Multi Caps, Sanyo-Oscon Caps, Caddock Resistor etc... Plus Optional OPA627's.

### ASSEMBLAGE ST-40



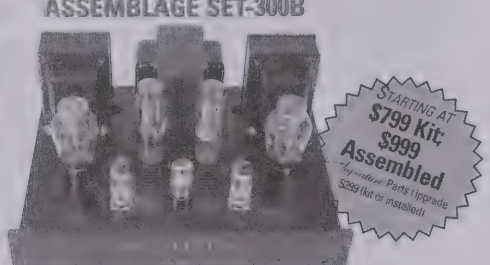

- The ST-40 Push-Pull Amplifier should become the classic of it's type and generation.
- Putting out in excess of 40 w/ch (closer to 50 watts if the truth be told) @ <1% THD, 20Hz to 20kHz, both channels driven, this compact power-house is an unbelievable buy.
- The input /driver stage uses a classic configuration of a 12AX7 feeding a pair of 12AU7's (these stages are regulated of course), feeding two pairs of EL34's.
- Quality parts from Multicap, Holco, Roderstein, Wima, and Kimber Kable.
- Custom Hammond output and power transformers.

### ASSEMBLAGE L-1




- The L-1 is a new improved and refined version of the original very popular Sonic Frontiers SFL-1 preamplifier (which retailed for $1400 USD between 1991 and 1996).
- A new incarnation of a classic pre-amp.
- This unit has 5 inputs (4 normal, 1 direct), tape in/out, and two sets of output jacks (makes bi-amping a whole lot easier), stereo/mono switch, mute, tape, and direct/normal switching.
- High quality Noble Balance and Volume pots.
- Supplies with Sovtek 6922, configurable to use 12AT7.
- Standard parts includes high quality components from Multicap, Wima, Solen, Holco, Bourns, Kimber, Telefunken, CTS and Panasonic.

### ASSEMBLAGE SET-300B




- Single Ended 300B Output Stage for a whopping 7-8 watts of power in STEREO, (16 watts MONO).
- Zero global negative feedback.
- 4, 8 and 16 Ohm output taps.
- Tube rectified B+ using 2 Mullard CV378/GZ33s.
- Custom designed output transformers.
- 'Coool' Blue LED power indicator. • Mute switch
- 300B Output tubes are not included in kit.
- Upgrade kits available: Multi Caps, Black Gate Caps, Vishay & Caddock Resistors, Cardas Binding Post, DH Labs wire, Kimber Jacks and Silver Wire etc... Plus

*Optional Black Gate Power Supply and attenuator kit.*

THE PARTS CONNECTION
DIV. OF SONIC FRONTIERS INTERNATIONAL

Visit our newly redesigned Web Site: **http://www.partsconnection.on.ca**
**2790 Brighton Road, Oakville, Ontario, Canada L6H 5T4**
Telephone (905) 829-5858 Facsimile (905) 829-5388
Toll Free Order Line 1-800-769-0747 (U.S. & Canada only)
E-Mail: TPC@partsconnection.on.ca

Reader Service #15

# A 20W $260 Amplifier

*This amplifier design packs plenty of power, but goes easy on your pocketbook.*

**BY JOSEPH NORWOOD STILL**

**PHOTO 1: Low-cost stereo amp.**

I wish to respond to the requests of many readers of *Glass Audio* who have expressed an interest in a reasonably priced, build-it-yourself amplifier. Michael E. Franzen of Frazee, Minn., was one of these readers ("Letters", *GA* 3/99). I hope this basic design satisfies his and other readers' requirements. I can truly appreciate the audio enthusiast who has some great ideas for building an amplifier but does not have the expensive test equipment to explore them adequately.

This stereo amplifier is a completely self-contained system (*Photo 1*). The front-panel controls of the amplifier feature a volume, balance, input selector switch, and an on/off power switch. Also located on the front panel is a three-position switch to select 8dB, 5dB, or 0dB global negative feedback. The feedback selector switch makes feedback versus non-feedback a non-event, since you can control it with the "flip of a switch."

I let the parts catalog design this amplifier. After a review of many catalogs, I settled on Hammond Mfg. Co. for the power and output transformers ($178) and Sovtek for the four 6L6GCs, matched quad, and three 6SN7s ($59). The Hammond transformers are available from Antique Electronic Supply, and the Sovtek tubes are available from Parts Express. The chassis and most other parts are available from Antique Electronics Supply, and a few parts are available at Radio Shack. Total cost for the entire amplifier is about $260.

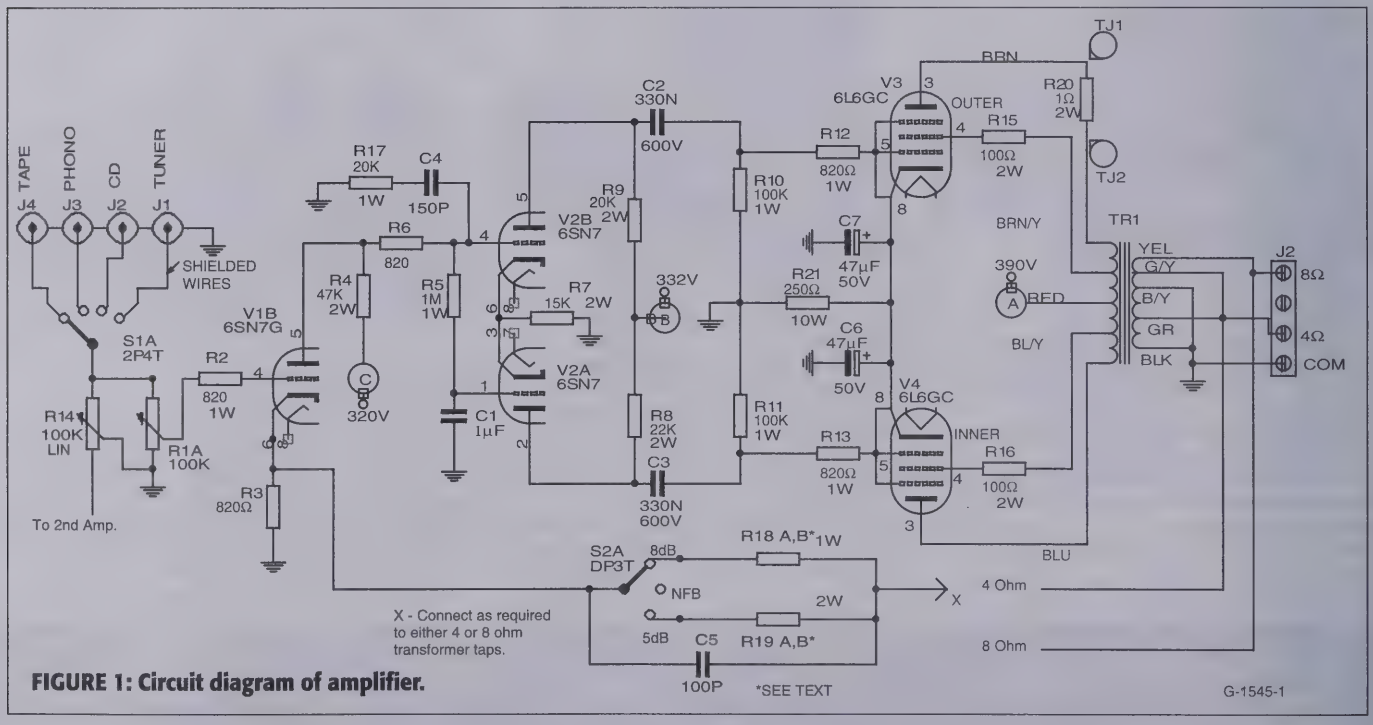



**FIGURE 1: Circuit diagram of amplifier.**

# In Southern California, We Get All Wiggly!

**At Upscale Audio, we dig tubes. And to prove it we display over 40 different tube amps, pre-amps, and digital products. And that's just in tubes, not even counting solid state. And we have back stock to go, because we know you get all wiggly and want to get it home now. We're the same way.**

***New CARY CAD-2A3***—You should have seen us shakin' and a groovin' when we first heard these. 15 watts of pure class A using four of the stunning KR 2A3 triodes. Available as a power amp at $3795 or integrated at $3995.

***BAT VK-30SE***—The 6H30 Supertube preamp that will give you a glimpse of the VK-50SE performance at a price that can't be touched.

Upscale Audio can have your VK-30, VK-5i, VK-50, and VK-D5 upgraded to SE status. Call or go to www.upscaleaudio.com for details.

## The Best $1500 CD Player Costs About $500

**Don't believe it? To read the reviews of some of the world's most respected audio journalists go to our website or call for info and re-prints.**

**The AH! Tjoeb (Tube) '99 CD Player—$450** (**Upscale Audio** *exclusive! Order online*) **6922 TUBE Output Stage with Dedicated Toroidal Power Supply • MARANTZ based, modified in Holland • Finest grade Burr–Brown op-amp for lowest noise • Quality Teflon insulated wire in signal paths • Adjustable output level assures perfect system matching**

***TUBE Upgrades***—The largest selection in North America. Obsessive selection process using the finest equipment available. Low noise pre-amp sets. TRULY matched power tubes. In stock now: Svetlana KT88, Ei KT90 Type 3 and factory matched vintage Genelex KT66.

*"My other tube discovery showed, yet again, how much those of us in Tubeland rely on good, no make that great dealers. I've mentioned* ***Kevin Deal of Upscale Audio*** *before in this column, and here he's come through again."* —Tom Davis, ***Positive Feedback Magazine***

**AUTHORIZED DEALER:**

**Audible Illusions, Golden Theater, Balanced Audio Technology, Cary, Benz, Golden Tube, PSB, Anthem, Ah!, Sunfire, Tannoy, Sonic Frontiers, Speakercraft, B&K, Meadowlark, Rega, Coincident Speaker Technology, Chang Lightspeed, Basis, Nordost Flatline, Kimber, Magnum Dynalab, Grado, Manley, Harmonic Technology and others by order.**

UPSCALE AUDIO
rare tubes • highest fidelity

www.upscaleaudio.com
2504 Spring Terrace • Upland, CA 91784
VOICE [909] 931-9686 • FAX [909] 985-6968

Reader Service #90

**TABLE 1**

**AMPLIFIER PARTS LIST (REPEAT ALL PARTS FOR STEREO)**

| | | |
|---|---|---|
| C1 | 1μF, 200V, metal film | RS 272-1055 |
| C2, C3 | 0.33μF, 600V, polyester | AES CSD33-600 |
| C4 | 150pF, 500V, silver mica | AES C-SM150 |
| C5 | 100nF, 500V, silver mica | AES C-SM100 |
| C6, C7 | 47μF, 50V | RS.4-11940590 |
| R1 | 100k, dual pot, audio taper | AES R-V100kD1 |
| R2, R3, R6, R12, R13 | 820, 1W, carbon | AES |
| R4 | 47k, 2W, metal oxide (M.O.) | AES |
| R5 | 1M, 1W, carbon | AES |
| R7 | 15k, 2W, M.O. | AES |
| R8 | 22k, 2W, M.O. | AES |
| R9 | 20k, 2W, M.O. | AES |
| R10, R11 | 100k, 1W, carbon | AES |
| R14 | 100k, single pot, linear | AES R-V100K |
| R15, R16 | 100, 2W, M.O. | AES |
| R17 | 20k, 1W, carbon | AES |
| R18A | 10k, 1W, carbon (for 8Ω) | AES |
| R18B | 15k, 1W, carbon (for 4Ω) | AES |
| R19A | 27k, 1W, carbon (for 8Ω) | AES |
| R19B | 39k, 1W, carbon (for 4Ω) | AES |
| R20 | 1Ω, 2W, M.O. | AES |
| R21 | 250Ω, 10W | AES |
| S1 A, B | 1-pole, 6-position, rotary switch | RS 275-1386 |
| S2 A, B | DP3T on-off-on switch | RS 275-710 |
| W1 | 4-conductor, shield cable | RS 910-1604 Note: order W1 from Radio Shack.com (1-800-442-7221) |
| TR1 | Hammond, 30W, 5kΩ Ct, Sec. 4, 8, 16Ω | AES P-T1645 |
| TJ1, TJ2 | Insulated tip jack | AES S-H260/S-H261 |
| V1S–V7S | Octal, saddle, wafer | AES P-ST8-141 |
| J1–J4 | Female, phono jack, classic mount | RS 274-852 |
| J5–J6 | Banana jack (red/black) | RS 274-6627 |
| V1–V3 | 6SN7 (Sovtek) | PE |
| V4–V7 | 6L6GC (Sovtek), matched quad (must be 6L6GC for ultralinear operation) | PE |

RS—Radio Shack
AES—Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283, (480)-820-5411
PE—Parts Express, 725 Valley Dr., Springboro, OH 45066, (800)-338-0531

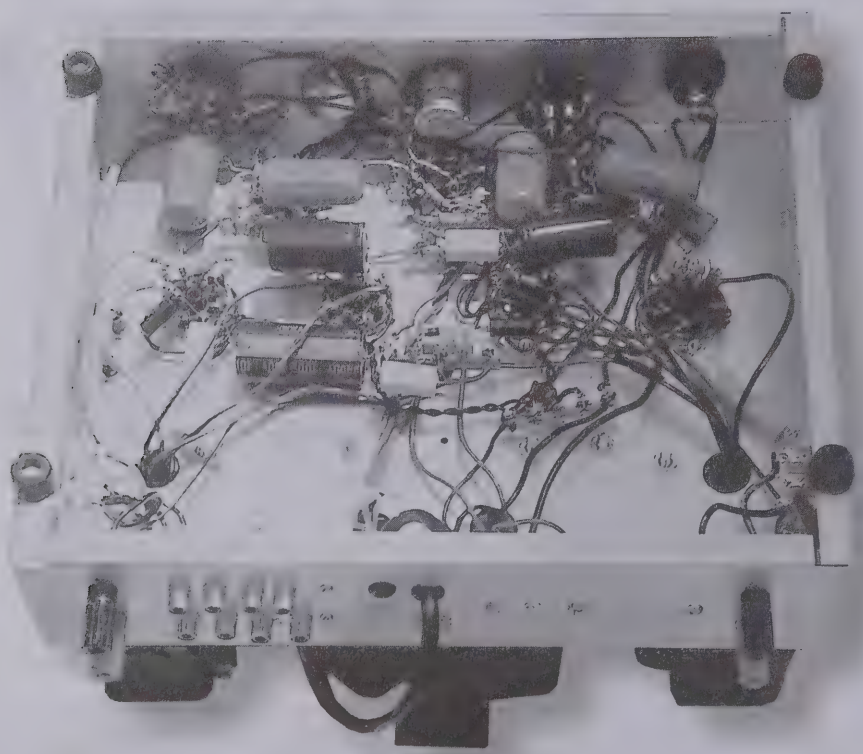


**PHOTO 2: Inside the amp.**

**TABLE 2**

**TUBE DATA**

| 6L6GC CLASS AB1 | ULTRALINEAR MODE |
|---|---|
| Plate voltage (plate to cathode) | 360V |
| Cathode resistor | 250Ω (+30V) |
| Grid signal voltage (RMS) | 23V |
| Zero signal plate current | 120mA |
| Max. signal plate current | 140mA |
| Load resistance (plate to plate) | 5kΩ |
| Plate dissipation (per tube) no signal | 21.5W |
| Plate dissipation (per tube) max. signal | 19.5W |
| Harmonic distortion at 1kHz, no feedback | 1.2% |

6SN7: Ebb + 320V, Eb + 115V, EK + 3.5V (Driver, 1st stage)
6SN7: Ebb + 332V, Eb1 + 250V, Eb2 + 248V Ecl, +120V, Ec2 + 110V, Ek1 + Ek2 + 124V (Inverter)

## THE ULTRALINEAR AMPLIFIER

The amplifier's performance is superb—even window rattling—at its 20W output. The modest 8dB inverse global feedback gives it liveliness. Its bass handling is surprisingly strong. In a living room setting, this amplifier is more than adequate in the power department.

The amplifier operates in the ultralinear mode, which exhibits better features than the pentode mode and has a damping advantage over a pentode of better than five times. The ultralinear mode also provides modest degenerative feedback within the 6L6 stage. The 8dB feedback is modest and takes nothing away from the amplifier's performance.

I selected 8dB because it limited distortion to less than 1% from 35Hz–20kHz at 20W. The 1% distortion figure is at the point which the most critical ear can detect distortion. The amplifier's frequency response is flat from 30Hz to 20kHz at 20W. The amplifier also operates without feedback or with a very modest 5dB of feedback.

The amplifier is built on a 10 × 12″ aluminum chassis. It has a pleasing, aesthetic, commercial look. *Figure 1* shows the circuit diagram of the amplifier, and *Table 1* is the parts list.

The design features push-pull 6L6GCs preceded by a duo-triode, long-tailed phase inverter, and a triode first-stage (*Photo 2*). The amplifier requires a 0.3, 0.6, or 0.8V (RMS) drive signal for 20W output with 0, 5, or 8dB of global feedback applied respectively. The tube data reveals that the dissipation levels of 21.5W (UL) are within the recommended dissipation ratings for 6L6GCs (*Table 2*).

## DRIVER STAGES

The first stage of the amplifier uses one-half section of a 6SN7. This stage's distor-

# "a major artistic achievement"

Dr. Harvey *Gizmo* Rosenberg, www.enjoythemusic.com/triode/tgawards

**The best audio output transformers in the world — with specs to prove it.**

"The highest quality audio transformer I have ever heard. Incredible low-end response."
Alex Aguilar, President
Audio Amplification, NYC, NY

"This new sample looks super! Congratulations to you and Menno on great design work. Consider this as an enthusiastic acceptance of production."
Christopher Russell, VP Engineering
Bryston Manufacturing, Peterborough, Ontario

"The build quality and reliability are excellent. ...simply the best..."
Gilbert Young, President
Blue Circle Audio, Innerkip, Ontario

" ...your design seems to be really elegant..."
Bill Chalmers, Innamp

"...absolutely amazed at the low frequency performance of your design..."
Dr. Vincent McGinn, Chairman Electrical Engineering Department, Northern Illinois University

**Ultra Wide Bandwidth Toroidal Output Transformers for Tube Amplifiers**

- Single Ended
- Push - Pull
- Triode
- Pentode / Super Pentode
- Cathode Feedback
- Unity Coupled

PLITRON
MANUFACTURING INC

8, 601 Magnetic Drive
Toronto, ON, Canada M3J 3J2
**www.plitron.com**
e-mail:techinfo@plitron.com
1-800-PLITRON
(1-800-754-8766)
Tel. 416-667-9914
FAX 416-667-8928

www.plitron.com

© 2000 PLITRON Manufacturing Inc.

We specialize in audio transformers.
Since 1983 Plitron has supplied
toroidal transformers to high-end equipment manufacturers.

Reader Service #70

tion with a 3V (RMS) output signal (no feedback other than the unbypassed cathode resistor) is less than 0.4% from 30Hz–20kHz.

The first-stage 3V output and 23V (RMS) output of the inverter drives the amplifier to full output. I selected the 6SN7 long-tailed phase inverter because it offers reduced phase shift and a stable feedback loop by eliminating a stage of amplification. Only the slightest degree of phase imbalance is evident between the two outputs in this type of inverter. Low-impedance direct cathode-coupling between sections contributes to this characteristic.

The long-tailed phase inverter has unequal output voltages due to the slightly higher gain of the grid-driven section. You can obtain balance between these output voltages by using a 20kΩ resistor on the plate of the grid-driver section and a 22kΩ plate resistor on the cathode-driven side of the inverter. The balance is maintained with eight different 6SN7s, which should provide a permanent fix. An anti-ringing R/C network (C4 and R17) is connected to the signal grid of the 6SN7.

The distortion of the 6SN7 stage (no external feedback) is less than 0.5% from 30Hz-20kHz at 23V (RMS) output. The push-pull effect should reduce this distortion figure to approximately 0.3%. The frequency response of the cascaded driver stages (with feedback applied) is flat from 30Hz-37kHz. The 23V (RMS) output will drive the amplifier (6L6GCs) to its full-rated output of 20W.

## OUTPUT STAGE

The 6L6GCs output tubes operate class AB1 in the UL mode under conditions shown in *Table 2*. I used self-bias. To ensure stability and maximum output, each cathode of the 6L6GCs is bypassed to ground with a separate electrolytic capacitor (47µF 50V).

The 6LGC plate-current for a single tube is measured across resistor (R20) at test jack TJ1 and TJ2. A 0.06V DC indication corresponds to a 60mA operating current. The tubes are interchanged at the left outer location of the amplifier chassis to select the best matching of the output tubes. The resistors are connected to the control grids and screen grids of the 6L6GCs to prevent oscillation of the output tubes.

To ensure stable operation of the amplifier, the inverse feedback loop must be connected to the output taps you are currently using. For example, when using the 4Ω tap, you must connect resistor R18A (10k, 1W) and resistor 19A (27k, 1W) to the 4Ω tap, but when you're using the 8Ω tap, connect resistor R18B (15k, 1W) and R19B (39k, 1W) to the 8Ω tap.

Be sure the output of transformer secondary impedance matches the impedance of your speakers. You must connect the secondary windings of the Hammond output transformer in a series configuration as shown in *Fig. 1*. If oscillation occurs when the amplifier is turned on, reverse the order of the coupling capacitors (C2 and C3) connected to the plates of the 6SN7 inverter.

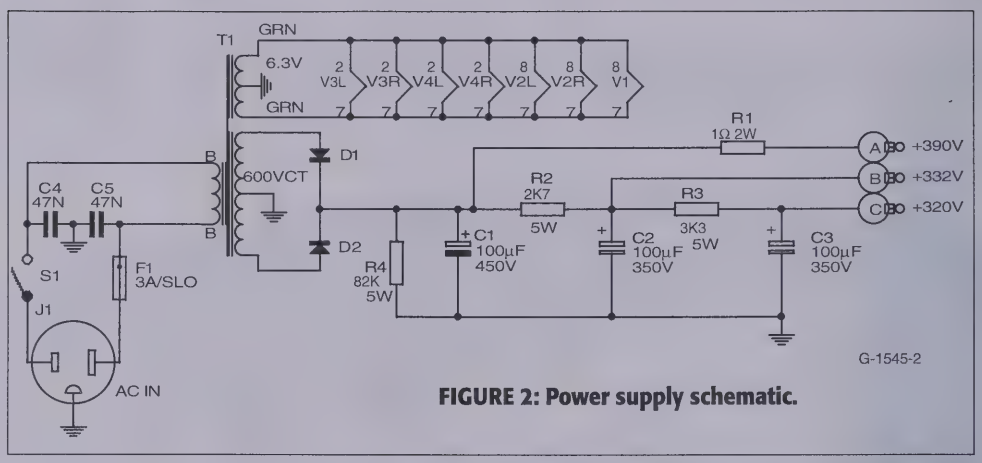



**FIGURE 2: Power supply schematic.**

## AMPLIFIER POWER SUPPLY

*Figure 2* shows the schematic and *Table 3* provides the parts list for the power supply. The plate-supply transformer provides the 6.3V AC required to operate all the filaments of the amplifier. The 5V AC filament (yellow leads) are not used. The high voltage winding of the transformer feeds a full-wave diode rectifier (D1 and D2). The AC ripple of the 396V DC output of the power supply is 0.6V. The output of the supply is 390V DC with the amplifier's output at 20W per channel.

## AMPLIFIER PERFORMANCE CRITERIA

The performance data of the amplifier is presented at its maximum operating levels. At 1W from 35Hz-20kHz, the distortion is less than 0.3% with 8dB global inverse feedback. The UL-mode distortion data for 5, 10, 15 and 20W operating levels with 8dB of feedback is shown in *Table 4*. You can obtain the distortion data for the 5dB and 0dB (no feedback) modes by multiplying the 8dB distortion numbers by 1.5 for the 5dB mode, and by 2 for the 0dB mode.

**TABLE 3**
**POWER SUPPLY PARTS LIST**

| | | |
|---|---|---|
| T1 | 600V, 250mA; 6.3V, 8A | Hammond P-T272JX |
| C1 | 100µF, 450V | AES C-ET100-450 |
| C2, C3 | 100µF, 350V | AES C-ET100-350 |
| C4, C5 | .047µF, 600V | AES C-TD1-630 |
| D1, D2 | 2.5A, 1000Piv; PTC 205 | RS-276-1114 |
| R1 | 1Ω, 2W | AES (M.O.) |
| R2 | 2.7k, 5W | AES (M.O.) |
| R3 | 3.3k, 5W | AES (M.O.) |
| R4 | 82k, 5W | PE 015-85K |
| FH1 | Fuse holder | RS 270-739 |
| F1 | Fuse 3AG, 3A, slow-blow | RS 270-1025 |
| S1 | Switch, SPST | RS 275-651 |
| AC Cord | 6′ | RS 278-1258 |
| Terminal strip | 5 lug | RS 274-688 (2 Packs) |
| Chassis | 10 × 12 × 3 | AES P-H123 |
| Solder | Rosin core | RS 64-006 |

PE—Parts Express (800-338-0531)
RS—Radio Shack 800-843-7422 for dealer nearest you
AES—Antique Electronic Supply, 6221 S. Maple Ave., Tempe, AZ 85283, 480-820-5411

**TABLE 4**
**ULTRALINEAR MODE (CLASS AB1)**

TOTAL HARMONIC DISTORTION %

| FREQ. | 5W | 10W | 15W | 20W |
|---|---|---|---|---|
| 35Hz | 0.34 | 0.36 | 0.66 | 1.00 |
| 100Hz | 0.28 | 0.34 | 0.50 | 0.60 |
| 1kHz | 0.16 | 0.24 | 0.42 | 0.44 |
| 10kHz | 0.16 | 0.28 | 0.48 | 0.52 |
| 15kHz | 0.17 | 0.34 | 0.54 | 0.65 |
| 20kHz | 0.19 | 0.40 | 0.64 | 0.78 |

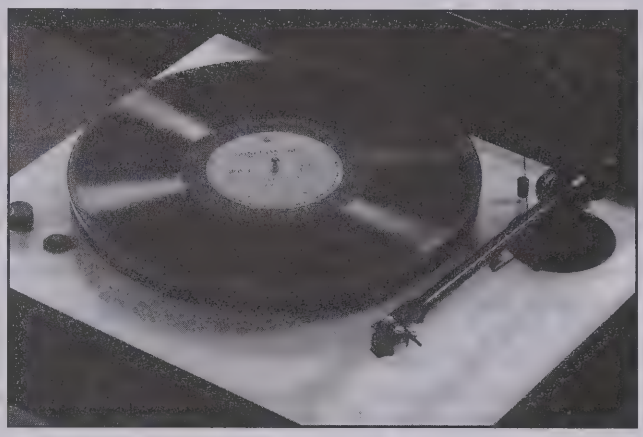
Note: 8dB feedback, 8Ω, speaker tap

**TABLE 5**
**TEST EQUIPMENT USED**

H-P 331 A distortion analyzer
Protek 6502 oscilloscope
Heathkit Sine/square audio generator, 1C-5218
DMM Radio Shack 22-168 A

# THORENS

## *Still The Same High Quality Turntables That Made Us The Legendary Competitor Of Garrard, Dual, And All The Others From The Vinyl Heyday*



*PRICED FROM $570 TO $8,000*

WE ALSO SELL THE ORIGINAL PARTS
FOR ALL OUR THORENS MODELS

WRITE FOR LITERATURE ON THE NEW LINE OF THORENS
AMPS...PREAMPS...TUNERS...CD PLAYERS...LOUDSPEAKERS

**THORENS OF AMERICA**
84-03 CUTHBERT ROAD, KEW GARDENS, NY 11415
PHONE: 718-847-4289 • FAX: 718-849-7698
WWW.THORENS.COM

*THE LEGEND CONTINUES...*

Reader Service #68

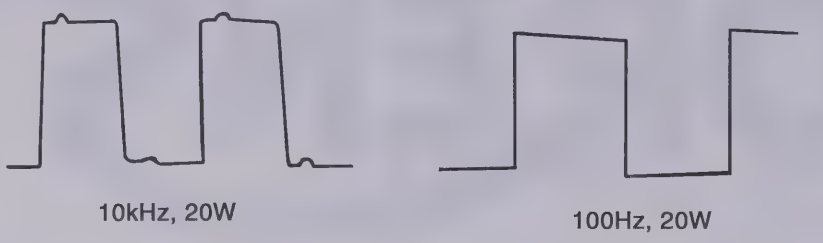



**FIGURE 3: Square-wave oscillograms for the 20W UL mode with 8dB global feedback applied.**

G-1545-3

The amplifier-distortion measurements were made using the 8Ω output taps, and the feedback was selected so the 4Ω output measurements mimicked the distortion of the 8Ω output taps. The square-wave oscillograms for the 20W UL mode with 8dB global feedback applied are shown in *Fig. 3*. The 100Hz and 10kHz square waves exhibit slight low- and high-frequency rolloff while the 1kHz square wave (not shown) is reproduced almost perfectly. No high-frequency ringing occurred with the amplifier reproducing the 10kHz square wave, even with a 0.1μF capacitor shunted across the transformer secondary (indicating good high-frequency stability).

The amplifier's frequency response at 20W output is flat from 30Hz-20kHz. The noise, measured with the input open, is 3mV. These measurements were made using 8dB of global feedback.

Note: If you use a record player with a magnetic cartridge, it will be necessary to purchase a phono preamplifier. The Esoteric Sound Professional Moving Magnet Preamp costs $80 (630-960-9173).

## CONSTRUCTION TIPS

I used point-to-point wiring. Most components are tied to the 5-pin terminal strips. The center terminal is ground, and components requiring a ground are tied to it. Also, components requiring a ground are tied to the ground lugs of the saddle-wafer octal sockets.

All the transformers used in this amplifier are secured with 10-32 fasteners. All other components are secured with 10-40 fasteners. Three of the 5-pin terminal strips are located directly behind the three 6SN7s. The center-located terminal strip consists of two terminal strips forming a "U" configuration.

Another 5-pin terminal strip is located directly behind the two inner 6L6GCs. This is the mounting location for the two H.V. rectifiers (D1, D2). Two other 5-pin terminal strips are located on either side of the rear of the amplifier, and the secondary leads of the output transformers are soldered to these connectors.

The octal wafer sockets for the 6L6GCs have their slots facing toward the transformers. The octal wafer sockets for the 6SN7s have their slots facing toward the right side of the chassis. Follow this layout to get the best placement of the components.

You will note that the amplifier schematic has right amplifier and left amplifier pin connections delineated. The blue plate leads connect to the inner 6L6GCs and the brown plate leads connect to the outer 6L6GCs. Assuming the specifications of the output transformer stay consistent, you shouldn't have any problems with oscillation caused by improper phasing.

To be on the safe side when you first try out the amplifier, attach an inexpensive speaker to the output terminals to ensure no oscillation is taking place. As stated earlier, it may be necessary to reverse coupling capacitors C2 and C3. Also check the wiring carefully and be certain that the 20kΩ resistor goes to the plate of the grid driver side of the inverter.

The green heater leads from the power transformer should be twisted and tied to the first stage (driver) 6SN7 heaters. The heater wires should be branched out to the right and left channels 6SN7s and 6L6GCs. The wires cut from the extra long leads of the transformer are adequate to wire the amplifier. Use the heaviest-gauge wire on the filaments. Four-conductor shielded cable is used to connect the J1 through J4 phono jacks to the rotary switch. Ground the four-conductor cable at both ends.

Warning: Lethal voltages are present; exercise appropriate caution when constructing the amplifier, and never leave the amplifier upside-down if children are present. ❖

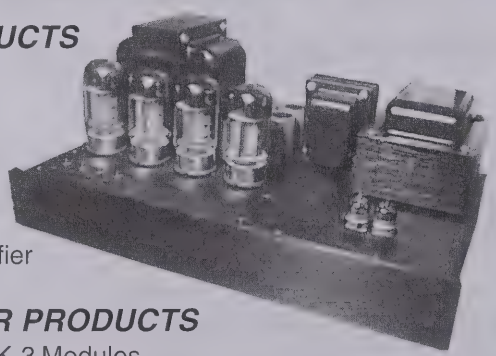
curcio audio engineering

*High Resolution Vacuum Tube Audio Systems*

OUR NEWEST PRODUCTS

MQ-100
100 WATT Reference
Mono-Block Power Amp

SARAH
Ultra Lo-Noise
All Tube Phono Preamplifier



OUR MOST POPULAR PRODUCTS

DYNACO PAS, ST-70 & MK-3 Modules
CD12V - Full Vacuum Tube Digital Processor
Daniel II Reference Preamp & Electronic Crossover

Your technical reference: www.curcioaudio.com

✓ Dr. DYNACO - Technical Support & PDF Manuals
✓ Catalogue w/ Photos & Schematic Diagrams
✓ Useful DYI Files, Links & Free Passive Preamp

Post Office Box 24605 San Jose, CA 95154
Phone (408) 269-4273 FAX: 1#1 After Answer
e-mail: curciojj@bayarea.net

CAE

Reader Service #61

**M-60 Mk. II Kit**
$2495 pair
60 Watts into 8 ohms
OTL Purity

Output Transformerless Purity and Power
Frequency Response: 1Hz-200KHz
Power Bandwidth: 2Hz-100KHz
Authoritative, Tuneful Bass  Graceful Highs and Midrange

Reviewers:

"WOW! They are great! Buy them, build them, and enjoy. ...very transparent and very fast. ...capable of very deep bass without loss of control. It was almost spooky when I noticed the silence behind the music." Jennifer Crock -Positive Feedback-

"...drive like hell to the nearest Atma-Sphere dealer and clap your ears on a pair of these."  Art Dudley -Listener-

"...it becomes obvious that the Atma-Sphere [M-60 Mk.II] is one of those rare electronic components that gives you the best of both worlds: transparency and natural musicality." Peter Moncrieff -International Audio Review-

"...yes, from the very first, I heard both- magic and accuracy. ...the M-60 Mk.II has a very extended but also extremely smooth and non-fatiguing top end. ...the particular combination of virtues and almost complete lack of faults offered by the M-60 Mk.II is extremely rare and coincides almost perfectly with how I perceive music, both live and recorded. Todd Warnke soundstage! soundstage.com

Customers:

"If the new review from Soundstage is an indication you may have to ramp up production of the M-60s. I've had mine for almost 2 years and love 'em now more than when I built them. One of the best purchases I've ever made. Thanks!" Bill S -T

"When I say the M-60s are terrific amps, I have to continually redefine 'terrific'. I have owned many amps over the years... but none of these can be described as 'transparent' when compared to the M-60." -from a customer review on audioreview.com, Jerry S. -CO

"I would like to express my deepest regards to you and your team. Harvey [Rosenburg] was indeed right when he stated [in a Positive feedback review] that you are going to create a revolution with your designs. One of my friends who is a very critical person... and extremely difficult to satisfy, was overwhelmed by the M-60 Mk.II. He called me the day after to say that he was dreaming about the amps the whole night!...It should be stated that I do not normally get overly enthusiastic about amps. During the last decade many have passed through here. But this was really extraordinary... I must admit that it was the greatest musical experience that I have ever had." Patrik K -Sweden

CALL NOW:
For information on our other amps and preamps
Class A, All Triode, Zero Feedback, Fully Differential and Output Transformerless

# Electronics for those who prefer music!

ATMA SPHERE®

160 So. Wheeler St. Paul, MN 55105 Phone: 651-690-2246 FAX: 651-699-1175 http://www.atma-sphere.com

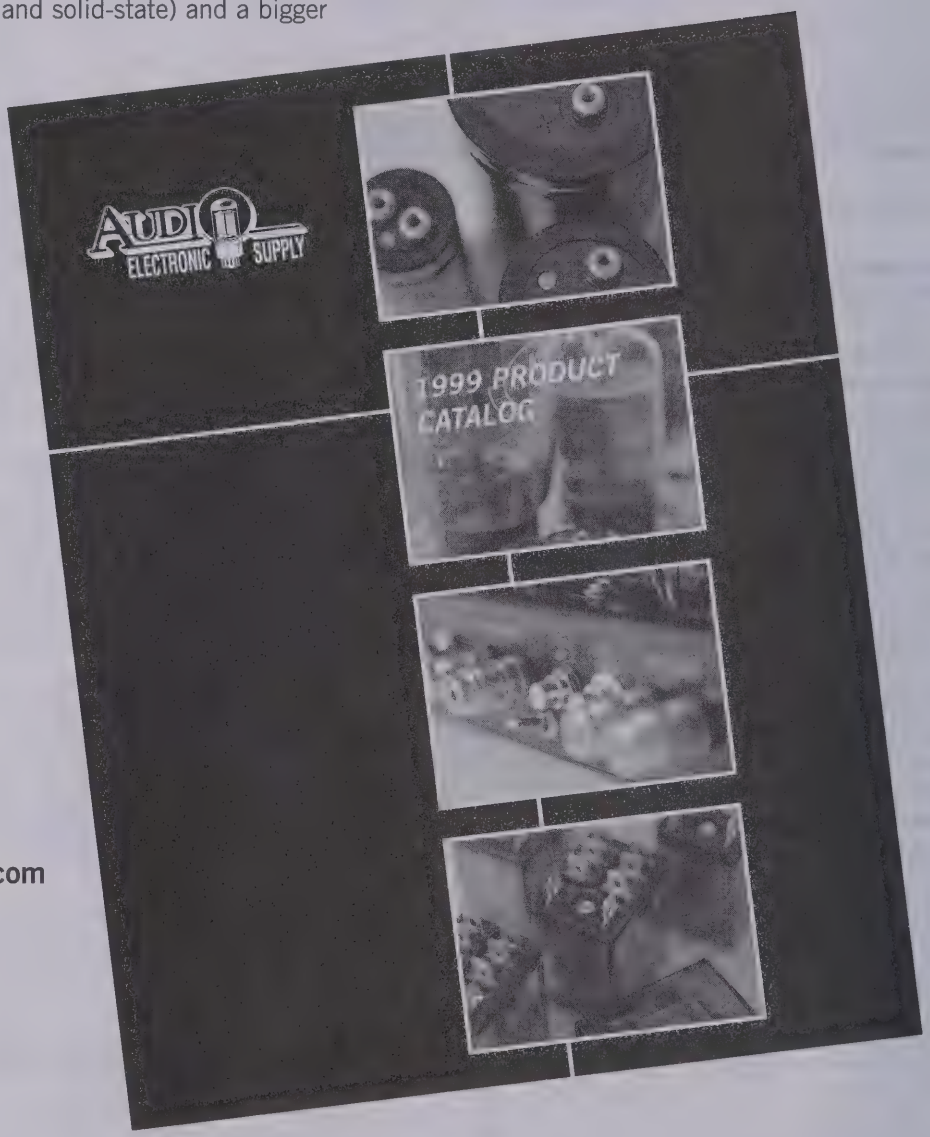
**ATMA-SPHERE MUSIC SYSTEMS, Inc.**

*Reader Service #25*

# *Sweet Dreams Are Made of These...*

Top quality capacitors, resistors, tubes, transformers, cables, chassis, and switches. All at fair prices from folks obsessed with customer service.

Our Audio Electronic Supply catalog is completely updated and redesigned for 1999. New kits (both tube and solid-state) and a bigger selection of parts than ever before for the serious and amateur audio builder.




**Call today for the original analog pressing, or visit www.audioeletronicsupply.com for the digital remaster.**

AUDIO ELECTRONIC SUPPLY

*A Subsidiary of Cary Audio Design*

111-A Woodwinds Industrial Court
Cary, NC 27511 USA
919.460.6461
919.460.3828 Fax
E-mail: info@audioelectronicsupply.com
www.audioelectronicsupply.com

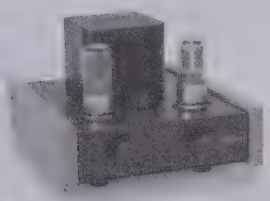
MasterCard VISA

# The Excitement Is Building!

NEW KITS AND A BRAND NEW CATALOG

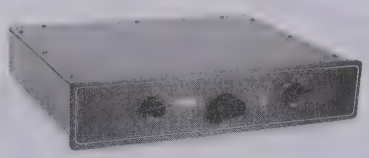
There's nothing like the excitement of building your own equipment. That's why Audio Electronic Supply simply concentrates on supporting the music lover and audio builder with quality kits and a comprehensive inventory of parts. Everything we've learned in audio is reflected in the design and build quality of these kits, and in cultivating a base of satisfied repeat customers. The search for affordable high end products ends at Audio Electronic Supply. See for yourself in our new and expanded catalog.

There's a kit here for you—and a world of musical fun for you and your family!



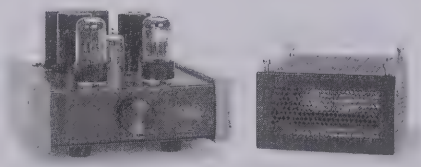
***AE-3 Preamplifier***

Kit: $399 Assembled: $599



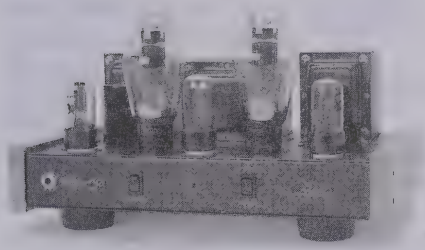
***AE-2 MOSFET Preamplifier***

Assembled: $499



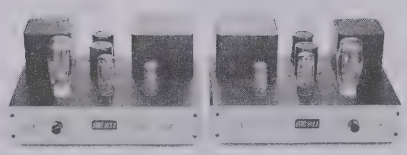
***PH-1 Phono Preamplifier***

Kit: $399 Assembled: $549



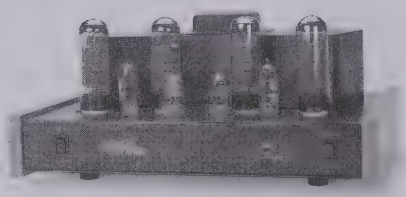
***SE-1 Signature Single-ended Triode Power Amplifier***

Kit: $849 Assembled: $1,049
(without output tubes)



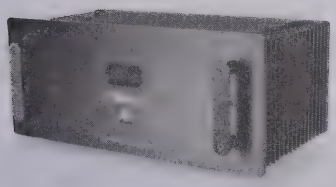
***SE-811 Single-ended Mono Block Power Amplifier***

Kits: $1,199/pr Assembled: $1,499/pr



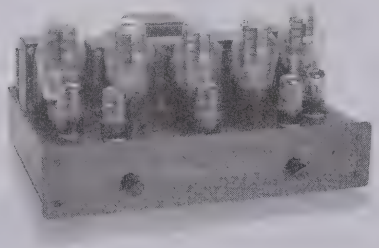
***AE-25 Push-pull Power Amplifier***

Kit: $599 Assembled: $799



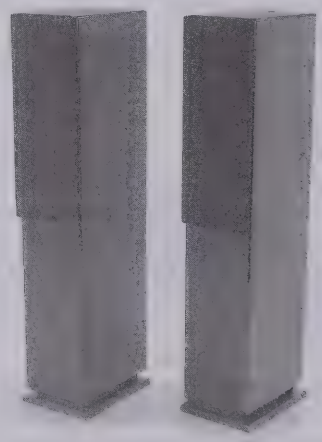
***SET-II MOSFET Single-ended Mono Block Power Amplifier***

Kit: $1,199/pr Assembled: $1,499/pr



***SE-5 Single-ended Five-Channel Amplifier***

Kits: $1,995 Assembled: $2,395



***SP-301 Loudspeaker***

Kit: $799/pr Assembled: $1,099/pr

***Order online:*** **www.audioelectronicsupply.com**
***Please call for a free catalog:*** **919.460.6461**

AUDIO ELECTRONIC SUPPLY
*A Subsidiary of Cary Audio Design*

111-A Woodwinds Industrial Court
Cary, NC 27511 USA
919.460.6461
919.460.3828 Fax
E-mail: info@audioelectronicsupply.com
www.audioelectronicsupply.com

MasterCard VISA

*Reader Service #13*

# A Hybrid Amp Revisited

*This hybrid amp combines the best of both worlds with a tube, interstage transformer, and MOSFETs.*

**BY WIM DE HAAN**

Before this year, I had mentally designed four hybrid amplifiers, but had never actually built one. This year I finally started to develop this amp and to try out my own hybrid amplifier, which uses a 5687 tube, SCR coupling capacitors, and Magnatec Power MOSFETs. The result is extraordinarily good.

My Dynaudio loudspeaker (10.5 ltr bass-reflex, a 17W75XL04 mid/low unit, and a T330D Esotar unit) is really in love with this amp. Music such as "Get Here," by Oleta Adams, and Neil Young's "Cortez the Killer," on the live *Weld* CD are phenomenal. Another good example is jazz guitarist John Scofield's "Dark Blue" (*Hand Jive* CD). In addition, my favorite classical piano music and my favorite music of jazz pianist Keith Jarrett is reproduced in an extraordinarily good way.

The amplifier seemed to understand my musical choices, so there was no reason to build another one. However, after reading an article by Guido Tent (in the Dutch periodical, *Audio & Techniek*, No. 69, May/June 1999, p. 38), I itched to try his idea. It inspired me, because old schematics with currently obtainable components such as transformers and semiconductors can lead, I find, to desirable results.

In the '30s and '40s many amplifiers were built with interstage transformers, and in the '60s they used such transformers in transistor amplifiers. In a 1995 Japanese magazine, I found a design with an op amp, an interstage transformer, and two N-Power MOSFETs.

After reading the article, I still had some questions about a design like this. A transformer? Wasn't this component eliminated in the past with great relief? However, the disappearance of the coupling capacitors and the unique nature of the design have motivated me to build this amplifier.

## COMPONENT CHOICES

As major components, I chose a 5687 tube (*Photo 1*), a Lundahl interstage transformer, and Magnatec Power MOSFETs. I chose the 5687 because I had several of them and had used them successfully in my previous hybrid. I selected the Magnatec MOSFETs because I had used them in other projects, also with good results. These MOSFETs are specially made for audio and are reasonably priced ($17.50 each).

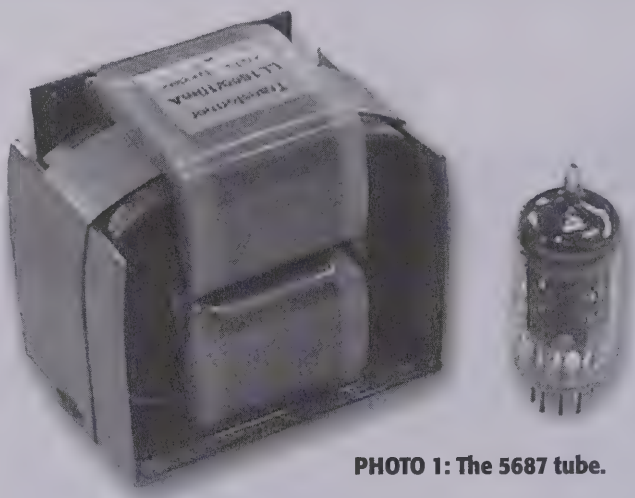


**PHOTO 1: The 5687 tube.**

The BUZ 900 has a TO-3 case, and the BUZ 900P a TO-247. There is also a version with two N-MOSFETs paralleled in one case (and, of course, versions with P-MOSFETs—the BUZ900DP and the BUZ905DP). In addition to those, Magnatec manufactures an N and P Power MOSFET in one case (the MAG90X95). Moreover, there is a 500W version in an SOT-227 case.

Then I needed to decide on an interstage transformer. Those of Tango and Tamura are simply too expensive for a trial project like this. After a time of surfing on the Internet, I chose a Lundahl interstage because of its good specifications, availability, and price. After receiving the transformers, I started constructing a prototype, as shown in *Photo 2*.

Meanwhile I e-mailed Guido Tent concerning the hybrid, asking him about the old schematics in *Audio & Techniek*, which he kindly sent me. *Figure 1* is the OrCAD® drawing of the schematic as built and tested by me.

## OSCILLATION PROBLEMS

The original schematics were only on paper and not actually built, so I did not notice that the LEDs were pictured incorrectly and that one of the junctions of the secondary winding was wrong. In building my amplifier, I noticed that my design oscillated, so I added an RC network. Another solution to eliminate the oscillation was to change the gate resistor from 249E to 1K5. The signal didn't change.

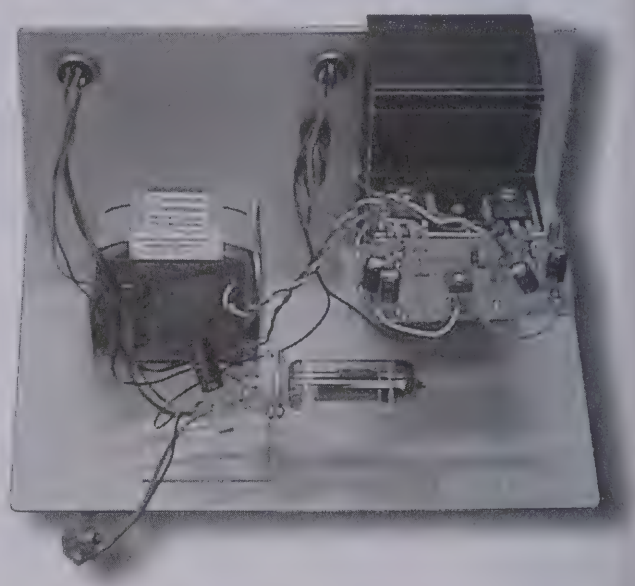


**PHOTO 2: Inside the prototype amp, top cover removed.**

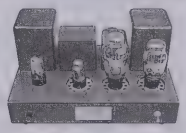
# SUN AUDIO amplifiers

## SV SUN AUDIO AMPLIFIERS, KIT & ASSY SERIES

★You can replace the power tubes for SV-series power amplifiers by other tubes with some alteration of the circuit in order to get different tonal characters.
As for power voltage, SV-kits are prepared for operation in U.S.A., European and Asian countries.

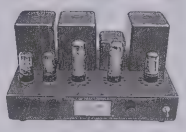
### POWER AMPLIFIER SERIES

**NEW ITEM SV-300BTE**



- Power 8W
- Tubes 300B : 1 6SN7GT : 1 6V6GT : 1 5U4G : 1

**NEW ITEM SV-PM200**



- Power 5W + 5W
- With 3 INPUT, REC IN and REC OUT terminals
- Tubes EL34 : 2 6SN7GT : 2 GZ34 : 1

**SV-300B MKII**
- Power 20W, with Interstage Transformer
- Tubes 300B : 2 6SN7GT : 1 5U4G : 1

**SV-2A3PE**
- Power 15W, with Interstage Transformer
- Tubes 2A3 : 2 6SN7GT : 1 5U4G : 1

**SV-KT88PE**
- Power 30W, with Interstage Transformer
- Tubes KT-88 : 2 6SN7GT : 1 5U4GB : 1

**SV-6L6PE**
- Power 20W, with Interstage Transformer
- Tubes 6L6GC : 2 6SN7GT : 1 5U4GB : 1

**SV-300BSM**
- Power 8W, with specially manufactured OPT
- Tubes 300B : 1 6SN7GT : 1 5U4G : 1
- Chemical Condenser less Circuit

**SV-2A3**
- Power 3.5W × 3.5W
- Tubes 2A3 : 2 6SN7GT : 2 5U4G : 1

**SV-KT88**
- Power 8W × 8W
- Tubes KT88 : 2 6SN7GT : 2 5U4GB : 1

**SV-300BE**
- Power 8W × 8W
- Tubes 300B : 2 6SN7GT : 2 5U4G : 1

**SV-6V6SE**
- Power 4.5W × 4.5W
- Tubes 6V6 : 2 6N7GT : 2 GZ34 : 1

**SV-EL34SE**
- Power 8W × 8W
- SV-6V6SE KIT and additional following parts for upgrade.
  Tubes EL34 : 2 pcs Resistors : 3 items Name plate

**SV-BONNET** Metal cover which can be fitted to all SV-series kits.

### SVC SERIES

**SVC-1000**

- Pre-Amplifier with CR-type Phono Equalizer
- Power Transformer, Choke Coil and Output Transformer specially manufactured by Tamura Corp.
- Tubes ECC83 : 1 ECC82 : 5 6X4 : 1

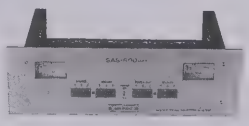
**SVC-500**
- Line Control Amplifier with baranced Input/Output Transformers.
- Power Transformer and Choke Coil manufactured by Tamura Corp.
- Tubes ECC82 : 2 6X4 : 1
- ★Also available : The Kit without Input/Output Transformers.

### SCD-660 Line Transformer for CD player

- High-performance Line Transformer developed jointly with Tamura Corp.
- Equiped with both XRT Canon and RCA Input/Output terminals.
- Balanced-Unbalanced conversion function.

**NEW ITEM**

### SAS-600MKII Stereo Sound Selector System



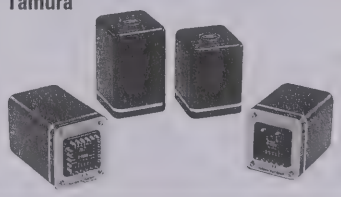
- Main Amplifiers : 3
  Pre Amplifiers : 3
  Source : 3
  Speaker System : 3
- World-wide Power Supply

### SAT-1000 Step-up Transformer for MC Cartridge
- Suitable for almost all MC Cartridge.
- LP Playing of fine quality.

### SVPE-700CR CR type Phono Equalizer
- Power Transformer and Choke Coil manufactured by Tamura Corp.
- Tubes 12AX7 : 2 6X4 : 1

**New Output Transformers from Tamura**

### Permalloy Core F-7000 Series



- Excellent characteristics
- High Quality

**We can offer:** ★All Transformers manufactured by Tamura Corporation.(Catalog free)
★Mr. Sakuma's Special Transformers
★Electronic Tubes and other Parts to assemble the Amplifier
★Other Audio Equipment

**Don't hesitate to make inquiry to our fax No. +81-3-5296-0272**
**Website : http://www2.big.or.jp/~sunaudio/**
**E-mail : sunaudio@big.or.jp**

**We are an export agent of Tamura Corporation, the excellent manufacturer of audio transformer.**

## SUN AUDIO CO.,LTD.

2-23-9 Kanda-Sudacho, Chiyoda-ku Tokyo, 101-0041, Japan
Phone +81-3-5296-0271 Fax +81-3-5296-0272

| AGENCY | | | | |
|---|---|---|---|---|
| FONE | SEOUL KOREA | PHONE 342-701-7090 | FAX 342-706-9614 |
| MONSOLOMUSICA S.N.C. | LEGNANO ITALY | PHONE 0331-594153 | FAX 0331-454906 |
| AUDITORIUM 23 | FRANKFULT GERMANY | PHONE 069-465202 | FAX 6196-84226 |
| CREATIONS AUDIO | PARIS FRANCE | PHONE 1-4020-9528 | FAX 1-4020-9533 |
| HIFI-TEAM | AUSTRIA | PHONE 02958-8622 | FAX 02958-8623 |
| AUDIO CRISEL, S.L. | MALLORCA SPAIN | PHONE 71-404783 | FAX 71-400304 |

US AGENCY **H.A. CORPORATION** ✦ Oregon, USA ✦ **Email:** haelec@europa.com ✦ PHONE 503-644-7282 ✦ FAX 503-644-6713

*Figure 1: Woofer*

*Figure 2: Tweeter*

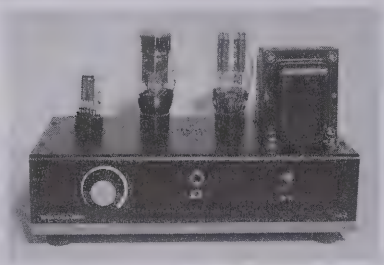
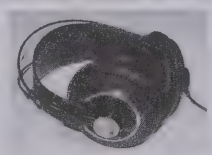


*Figure 3: Stereo*




You don't have to spend a fortune to experience high-quality tube audio. A system using a tube headphone amp from Wheatfield Audio (such as the HA-2, shown above), a CD player, and a good set of dynamic headphones can provide more accurate, realistic sound reproduction than systems that cost tens of thousands of dollars.

Wheatfield Audio headphone amps are OTL (Output Transformer-Less) tube amplifiers designed specifically to drive headphones. They employ single-ended triodes, and use no negative feedback.

Visit our website for more information on the HA-2 and the new, even *more* affordable HA-1, or call our exclusive dealer, HeadRoom.

Wheatfield Audio headphone amps are available from HeadRoom

(406) 587-9466
(800) 828-8184

HeadRoom
www.headphone.com

Wheatfield Audio LLC • Andale, Kansas
*www.headphoneamp.com*

WHEATFIELD AUDIO

Reader Service #109

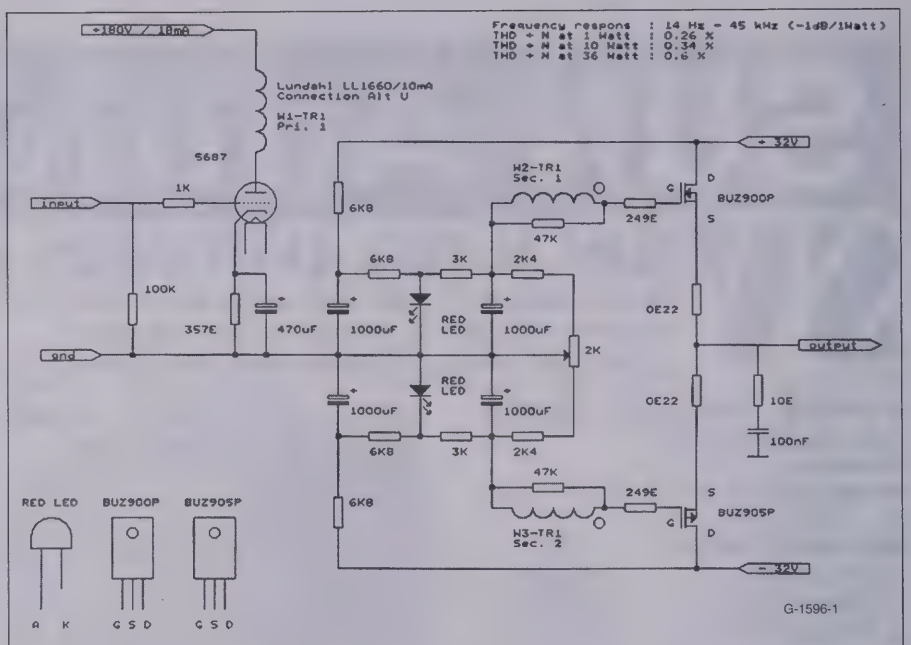




**FIGURE 1: OrCAD drawing of the schematic.**

The secondary winding of the Lundahl is such that if unloaded, a peak of 8dB will occur at 30kHz. With a resistor of 47k parallel to the secondary winding, the best result is reached between distortion and damping/frequency response. The amplifier now has a peak of a 0.5dB at 20kHz. Furthermore, its progress is straight, with the –1dB point at 14Hz and 45kHz, which is an achievement for a 1:1+1 transformer. An effort to improve the damping of the secondary winding with a paralleled RC network was not successful.

This all applies to the LL1660 Lundahl 1:1+1 interstage. This transformer is obtainable in three versions: a push-pull, a single-ended 18mA, and a single-ended 10mA. I chose the LL1660/10mA. It is wired according to the connection alternative. The configuration I chose is suitable for use in single-ended or push-pull, and with a primary current of 20mA. The 5687 tube is suitable for use with this current.

An alternative choice is a Border Patrol interstage transformer. This English company also manufactures a usable 1:1+1 interstage (part number ITPP-860). I mention this alternative, but I have had no experience with it.

**SOURCES**

More information on my hybrid amplifier:
http://www.homestead.com/whaan/files/index.html

Information on Lundahl transformers (datasheets):
http://www.lundahl.se/
Tel: + 46 176 13930

Lundahl Belgium:
http://www.degryse.com/
Tel: + 32 3 281 32 44

Information on Magnatec Power MOSFETs (datasheets):
http://www.semelab.co.uk/magnatec.htm
Tel: + 44 1455 554711

Information on Border Patrol transformers:
Tel: + 44 1273 276716

## PROMISING SOUND

At this moment, I can't say very much about the sound or music quality because I have built only one prototype (one channel), but in mono it sounds promising. Noticeable is the good audibility and clarity of the sound. The low end is dry, punchy, and tight. Even in mono, the music of Keith Jarrett fascinates me. The stereo and final version is not yet made, because I'm still wondering whether or not to try the amplifier with two N-Power MOSFETs. ❖


VISIT OUR *WEBSITE*
www.audioXpress.com
*or E-mail us at custserv@audioXpress.com*

# AE-25 Super Amp

*Reviewed by Charles Hansen & Ken & Julie Ketler*

PHOTO 1: Amplifier front view.

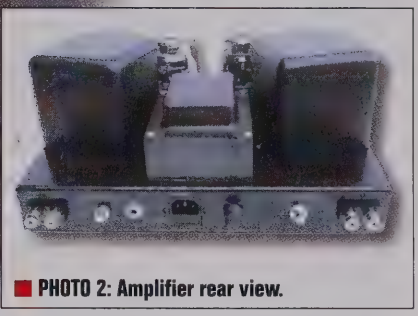


PHOTO 2: Amplifier rear view.

*Audio Electronic Supply, 111-A Woodwinds Industrial Ct., Cary, NC 27511, 919-460-6461, info@audioelectronicsupply.com, www.audioelectronicsupply.com. Kit $1000, assembled $1200. Dimensions: 7″ H × 14.63″ W × 12.5″ D; net weight: 31 lbs. Limited three-year warranty.*

The Audio Electronic Supply AE-25 Super Amp is a push-pull stereo power amplifier rated for 25W ultralinear or 15W triode-connected. *Photo 1* shows the front panel, which features the on/off and operate/standby switches and a blue LED indicator.

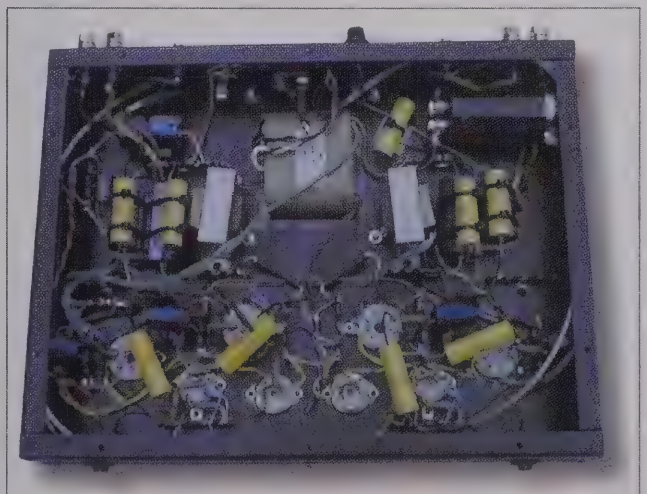


PHOTO 3: Interior view.

## CONSTRUCTION

The heavy-gauge steel amplifier chassis is extremely rugged. Ventilation holes surround each KT88 power tube socket. The two output transformers are canted toward the center at a 15° angle, providing a visually interesting backdrop for the tubes.

The rear panel (*Photo 2*) has the IEC power receptacle, a fuse holder for the output-tube fuse, a pair of high-quality gold-plated Teflon™-insulated RCA input jacks, and two pairs of high-quality gold-plated speaker binding posts for 8Ω speakers on U.S. 0.75″ spacings. A phone jack allows you to measure the output-tube bias current using a phone plug and cable set supplied with the amplifier.

The unit is furnished with a heavy power cord and three spare fuses. You can connect the power transformer primary for 120V or 240V mains.

*Photo 3* shows the amplifier with the bottom cover removed. While this particular unit was factory assembled, the assembly and operating manual is well thought out, with sequential assembly sketches reminiscent of the Heathkit manuals.

## TUBE-POLOGY

The review unit was wired for 15W triode operation and 8Ω speakers. The input signal for each channel arrives at the grid of the first half of a 6922/6DJ8, which is connected as a cathode-coupled phase splitter. There is no separate input gain stage, which explains why the gain, at 15dB, is on the low side. The cathodes of the 6922 are returned to –125V DC through a current source consisting of a parallel-connected 6FQ7 dual triode.

The plates of the 6922 drive a KT88 push-pull output stage, which you can connect either in triode mode or in ultralinear using screen taps on the output transformer. The output tubes are self biased by a cathode resistor bypassed by electrolytic and film/foil

caps. You must connect the secondary for either 4Ω or 8Ω speakers (an optional 4/8Ω switch is available). Global feedback is not used in the AE-25 amplifier, which can be operated without a speaker load (open circuit).

Since there is no global feedback, you can easily connect the AE-25 input stage for balanced input using an optional XLR input connector. A resistor and capacitor are also deleted in the process.

The power supply uses semiconductor diodes and dual two-stage pi networks with choke filters, one for each channel. The heaters are supplied from a single 6.3V AC transformer winding.

The standby switch opens the connection between the output tube cathodes and ground. The phone jack for measuring bias current and the output tube fuse are in series with this switch.

Audio Electronic Supply supplied the following tube complement:
2—Ei Yugoslav 6FQ7s marked L and R on the boxes (the manual specifies 6CG7s, but AES verified that the 6FQ7 is a direct replacement).
2—Sovtek 6922s
4—Chinese KT88s marked 1 through 4 on the boxes

## PRELIMINARY CHECKOUT

There was only a slight thump going from standby to operate and back, and during shutdown. With my ear against the speaker, I detected no hiss from either channel, but a very low-level hum from the right channel. However, the left channel had sufficient hum to be noticeable from a couple feet away. While it was acceptably quiet 6' from the speakers, I set about trying to find the source of the left-channel hum.

I tried moving the interconnects around relative to the AC power cords and speaker cables, and swapped all interconnects and cables from left to right. I also swapped the input and output signals left to right.

I could minimize the hum by removing either end of the left-channel interconnect, which was supplied from the AES AE-3 preamp at the time. The hum was independent of the input selector and the volume control setting, and even whether or not the preamp's AC power cord was plugged in.

I connected the AE-25 inputs to my own preamp and the left-channel hum level dropped to that of the right channel. I connected the AE-3 to my own power amp, and the sound was identical to that with my own preamp—just a very low hiss. When I returned to my original AE-3 preamp/AE-25 amp connections, the left-channel hum returned.

Finally, I installed the Jensen Iso-Max® CI-2RR dual audio ground isolator, which I had on hand for review, between the AE-3 and the AE-25. The hum dropped to an undetectable level in both channels. I connected the AE-25's right channel directly to the AE-3, with the CI-2RR still in the left channel, and the hum was very low, though not as totally quiet as before.

## MEASUREMENTS

I operated the AE-25 at 2W into 8Ω for one hour. I monitored the bias current during this time as it dropped from 310mA to 290mA, which is certainly close enough to the specified 285mA. The distortion was essentially the same for each channel.

The AE-25 does not invert polarity. Input impedance was 149k for both channels. The gain at 2.83V RMS output into the 8Ω load was 15.4dB. The output impedance was 4.4Ω at 1kHz and 4.5Ω at 20kHz, reflecting the lack of global feedback.

The frequency response for the AE-25 was within ±3dB from 4Hz to 78kHz, with 0dBr defined as 2.83V RMS at 1kHz into 8Ω. It was −0.2dB at 20Hz and −0.3dB at 20kHz. This is quite good and may reflect the added LF reserve in the output transformers with 15W triode operation. There was an additional gain peak of 3dB at 156kHz. When I connected a load of 8Ω paralleled with a 2µF cap, the response was down to −2dB at 20kHz and −3dB at 27kHz, with no HF peaking.

THD+N versus frequency at 1W into an 8Ω load did not exceed 0.53% from 20Hz to 20kHz. However, the high-frequency distortion increased rapidly with load.

*Figure 1* shows THD+N versus output power into 8Ω at 20Hz, 1kHz, and 20kHz. There was absolutely no strain right up to the point of maximum power. IMD performance was not as good: 6V pk-pk output test level which produced a CCIF (19kHz + 20kHz) 1kHz IMD product of 0.98%. The amplifier performed a bit better with the MIM 9kHz + 10.05kHz + 20kHz test signal, at 0.48%.

The clipping level is normally defined as that power where THD+N reaches 1%. However, the baseline distortion in tube amplifiers is fairly high at low power levels, so the generally accepted practice is to use 3% THD+N as the clipping point.

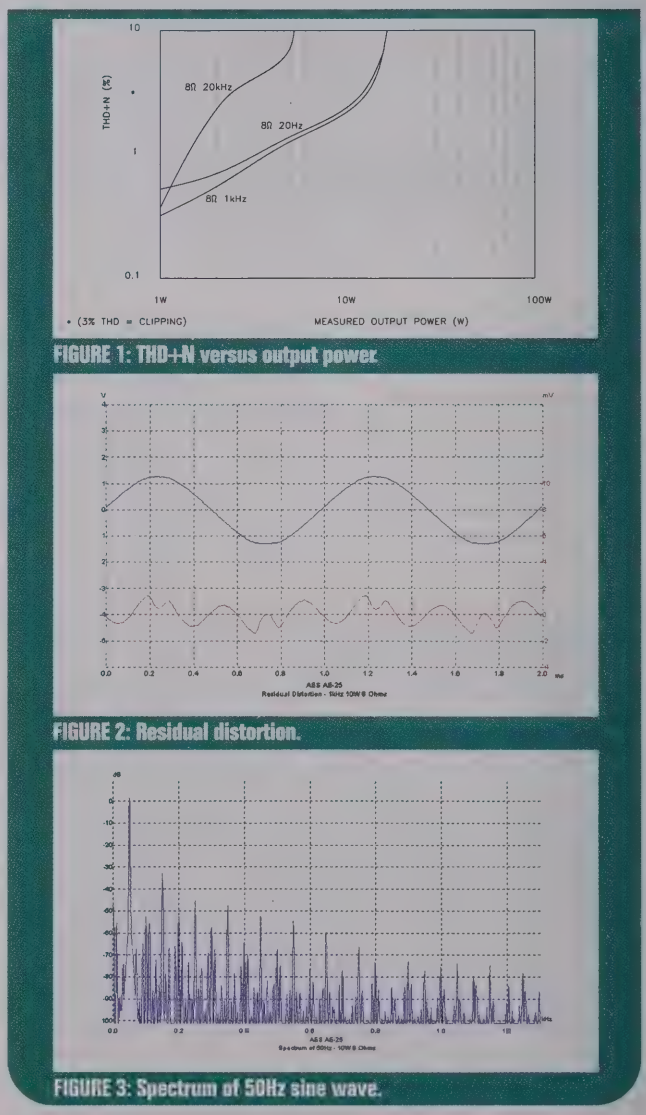



**FIGURE 1: THD+N versus output power.**



**FIGURE 2: Residual distortion.**



**FIGURE 3: Spectrum of 50Hz sine wave.**

**TABLE 1**
**MEASURED PERFORMANCE**

| PARAMETER | MANUFACTURER'S RATING | MEASURED RESULTS |
|---|---|---|
| Power output (RMS) | 15W RMS triode—8Ω 1kHz | 12.4W (3% THD) |
| | | 1kHz |
| Frequency response | 15Hz–20kHz ±0.5dB | 20Hz–20kHz ±0.3dB |
| Gain | –91dB | See text |
| Input impedance | 150kΩ | 149k |
| Sensitivity | 1.5V | |
| Total harmonic distortion | N/S | 0.53% max 1W 8Ω |
| IMD—CCIF (19 + 20kHz) | N/S | 0.98% at 6V pk-pk out |
| MIM (9 + 10.05 + 20kHz) | | 0.48% at 6V pk-pk out |
| Power requirements | 165W maximum, 80W stand-by | |
| Output impedance | N/S | 4.4Ω 1kHz, 8Ω |
| | | 4.5Ω 20kHz, 8Ω |
| Crosstalk, 100Hz (L-R) | N/S | –65dB |
| 1kHz | | –65dB |
| 10kHz | | –64dB |
| 20kHz | | –63.5dB |

With a 1kHz signal driving both channels, clipping occurred at 12.4W into 8Ω. My test bench 60Hz mains voltage was 118V AC. A bit less power was available at 20Hz—11.8W at 3% THD+N. The power available at 20kHz was much lower. I could get only 2.3W into 8Ω at 3% THD+N. The maximum power available at 20Hz and 1kHz was 16.2W, and the clipping was rounded as you would expect. Maximum power at 20kHz was 6.3W at 7.5% THD+N.

The distortion waveform for 5W into 8Ω at 1kHz is shown in *Fig. 2*. The upper waveform is the amplifier output signal, and the lower waveform is the monitor output (after the THD test-set notch filter), not to scale. This distortion residual signal shows a mix of low-order harmonics, with no evidence of any noise or fuzz.

The spectrum of a 50Hz sine wave at 5W into 8Ω is shown in *Fig. 3*, from zero to 1.3kHz. The THD+N measured 2.1%, and the harmonics are distributed throughout the spectrum, with the odd harmonics slightly higher than the evens. The second, third, fourth, and fifth measure –51dB, –31dB, –50dB, and –45dB, respectively.

The only artifact of power-supply rectification is at 120Hz, and it is below –86dB. The left-channel hum that I noted with the AE-3/AE-25 combination was not evident with the AE-25 alone.

The 2.5V pk-pk square wave into 8Ω at 40Hz showed moderate tilt. The 1kHz square wave was almost perfect. The leading edge of the 10kHz square wave showed one damped cycle of peaking at the 156kHz measured in the frequency-response test. When I connected 2µF in parallel with the 8Ω load, the leading edge became very rounded, without the HF peaking. ❖

## CRITIQUE

**Reviewed by Ken and Julie Ketler**

To break in the AE-25, we left the unit on continuously for a week. We listened to many of our favorite CDs each day and kept the unit in standby mode during downtime. For any listening sessions thereafter (either casual or critical), we allowed the Super Amp to heat up for at least a half hour. Although not recommended, we contemplated roasting marshmallows over the KT88s; boy, do Class A amps get hot!

For critical comparison, we used our own amp, a Valve Audio Laboratory VAA-100ES 30W push-pull design, which tends to have a mellow midrange tone and a somewhat rolled-off low end. Fortunately, it has an output volume control, so it was fairly easy to level-match both amplifiers accurately. To do so, we put a Radio Shack sound level meter in our listening position and played track #42 (1kHz tone) of the *Hi-Fi News & Record Review* Test Disc #3 until the outputs of both amps were within ½dB of one another.

### WHAT OUR EARS HEAR...

**TEST 1**
**TRACK 2—Jerusalem/Parry**

**JK:** Our amplifier made both the music and the voices become one during this piece of music. Neither one was dominant, which caused a somewhat nondescript piece without a lot of excitement. In contrast to this, the AE-25 amplifier clearly defined both the instruments and the voices, producing quite an exciting and clear piece of music. For example, I was able to hear the "plink" of a harp much more vividly than with our amplifier.

**KK:** The applause at the beginning and end jumps forward out of the speakers with the AE-25. Also, the cymbals and brass at the climax of this piece sound much more dynamic and striking.

**TEST 2**
**TRACK 4—Trumpet Concerto in C/Vivaldi**

**JK:** With the AES amplifier, this piece was so transparent that I was able to hear the "bouncing" of the violin strings. The trumpets' sound was strong and crisp. The sound filled the room as though they were actually playing in front of me.

**KK:** The Super Amp presents the upper harmonics of the trumpets in proper "alignment." I found it easier to hear the trumpets as individual parts, rather than as a wad of brass. A harpsichord in the back of the right channel is much more apparent as well. Our VAA-100ES amp tends to meld this sound together with the string section.

**TEST 3**
**TRACKS 5/6—Peter & the Wolf (narr)/Prokofiev**

**JK:** With the Super Amp, I could hear the narrator's lips smack as he spoke. The trumpets sounded loud and strong, and the tambourine's shake was perfectly clear.

**KK:** The flute and bassoon sound breathy and alive. The gunshots "by the tympani and the bass drum" are arresting, with a very nice low-frequency attack. The triangle and tambourine are also very clearly defined. In comparison, our VAA-100ES sounds as though it places a thin layer of cloth over the orchestra, which it hadn't before. Mr. Had has ruined another component in our system for us!

**TEST 4**
**TRACK 7—Welcome, Welcome/Purcell**

**JK:** With the AES amplifier, I was also able to place where the members of the chorus were standing. The string instruments were quite crisp-sounding throughout the piece.

**KK:** Easy to differentiate each individual voice in the choir. The transients of the harpsichord are sharper and less "liquid"-sounding. The oboes and recorders have a front-to-back placement that is less evident with the VAA-100ES. However, at louder listening levels, the higher notes of the female vocalists tended to overload the input of the Super Amp sooner than the VAA-100ES.

**TEST 5**
**TRACK 10—Corkhill (piece 2)**

**JK:** While listening to the AES amplifier, I could hear the drumsticks hitting the drumheads much clearer than with our amplifier. After the drums' dramatic finish, there was complete silence; not even a hint of static.

**KK:** The snares on the bottom drumheads are much more clearly defined with the Super Amp. The difference is particularly noticeable during quiet sections. With its lower-extending frequency response, crescendos are more startling as well.

**TEST 6**
**TRACK 14—Rio Napo RSS Demo**

**JK:** This song was a great one for comparing the Super Amp to our amplifier. On ours the music and voices together sounded "sizzley," as though they were burning in a pan on the stove. In contrast, the AES amplifier cleaned up the mess and made the music and the voices clear, distinct, and much more appealing. It also made it possible to "see" the placement of the instruments.

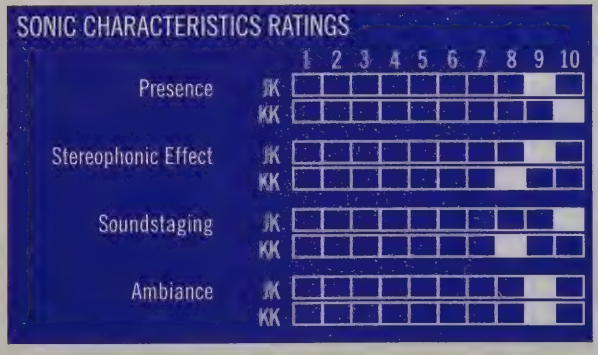
**KK:** The 3D imaging of this track sounds excellent with both amps. However, the chimes and shakers have a very nice sheen with the AE-25, while some of the bell rings have a very slight tinny quality with the VAA-100ES. The better bass response of the AE-25 reveals more punch, too. Nothing new there!

### FINAL THOUGHTS

Although only 15W strong, we found that this baby filled our living room with plenty of sound! The Super Amp also has a much more robust bass response than we're used to hearing in a tube amplifier. With our system, we use our tube amp to handle everything above 100Hz, and use a solid-state amp for the low bass. Heathens! The AE-25 is beautiful to run full range, making a biamped setup unnecessary.

The AE-25 Super Amp is a great example of taking a good design and making it excellent. Dennis Had's "stick-to-it-ive-ness" should inspire us all as audio amateurs with our own projects. Although $1,200 (or $1,000 if you buy the kit) could seem a bit pricey to some of us, the average consumer is not the target audience of this product. The Super Amp is, by no stretch of the imagination, a high-end product...and quite a bargain.

If you're considering making that leap into high-end audiophilia, the AES Super Amp is a great choice for your first time. If you are already a seasoned high-ender, you still owe yourself a listen.



# Kirksaeter's SL-60 Loudspeaker

*Reviewed by Joseph D'Appolito and Rita & Dennis Colin*

I ran a series of impedance, frequency response, and distortion tests on the Kirksaeter SL-60 loudspeaker. *Figure 1* is a plot of system impedance magnitude. At low frequencies the plot displays the double-peaked curve of a vented system.

The impedance minimum of 4.9Ω at 48Hz indicates the vented-box tuning frequency. There are additional local impedance minima of 4.9Ω at 250Hz and 3120Hz. Impedance phase lies between +36° and –42° over the full audio range. This system can reasonably be rated at 5Ω and should be an easy load for most amplifiers.

## FREQUENCY RESPONSE

*Figure 2* shows two far-field frequency-response curves for the SL-60. For this measurement I placed the microphone along the tweeter's axial centerline at a distance of 1.2m. This is a quasi-anechoic response[1] that is valid above 200Hz. The plotted responses have been normalized to 1m to obtain system sensitivity.

The SL-60 has two pairs of binding posts for bi-wiring. The dotted curve was obtained with the tweeter polarity indicated by the color coding on the binding posts. The broad dip at 3kHz is typical of a tweeter connected with the wrong polarity. Fortunately, it was an easy matter to reverse tweeter polarity and rerun the test. The solid curve was obtained with the tweeter connection reversed.

A little detective work will determine the actual tweeter polarity. *Figure 3* shows SL-60 step response with the normal and reversed tweeter connections. With the normal connection the initial rise produced by the tweeter is in the negative direction. With the connection reversed, the initial rise is positive-going—a strong clue that the tweeter is wired with its polarity opposite to that of the woofer.

*Figure 4* is even more revealing. Here I have plotted system excess phase. Again, the dotted curve is for the factory-marked tweeter connection. Notice that it produces 180° more phase shift at 15kHz than with the tweeter connection reversed. Whether this was a wiring error at the factory or whether Kirksaeter intends the system to be connected this way was not clear at the time of these tests. I performed all further testing with the tweeter connection reversed.

Near-field woofer and port responses (*Fig. 5*) are summed by the MLSSA system, giving proper weighting to the difference in area of the woofer and the port, to obtain the complete near-field low-frequency system response. The dip in woofer response at 50Hz is another indication of the vented-box tuning. Port acoustic output is also a maximum at this frequency. Woofer crossover inductance can cause the box-tuning frequency obtained with the impedance curve to be lower than that indicated by the woofer near-field response. When this happens, the latter is a more accurate measure of box tuning.

The system low-frequency response (*Fig. 5*) was spliced to the quasi-anechoic response (*Fig. 2*) at 218Hz to get the full-range system response. This result is shown in *Fig. 6*. Over the two octaves centered on 1kHz, sensitivity averages 86.8dB SPL/2.83V/1m. Relative to this level, response peaks 6.6dB at 16kHz. The –3dB low-frequency point is 60Hz.

*Figure 7* illustrates the crossover action. Acoustic crossover occurs just above 3kHz. Notice the woofer peak at 6kHz.

## CUMULATIVE SPECTRAL DECAY

The SL-60 cumulative spectral decay (CSD) response is presented in *Fig. 8*. This waterfall plot shows the frequency content of the system response following a sharp impulsive input at time zero. On the CSD plot, frequency increases from left to right and time moves forward from the rear. Each slice represents a 0.05ms increment of time. The total vertical scale covers a dynamic 32dB range.

Ideally the response should decay to zero instantaneously. Inertia and stored energy that take a finite amount of time to die away, however, characterize real loudspeakers. A prominent ridge parallel to the time axis would indicate the presence of a strong system resonance.

The first time slice in *Fig. 5* (0.00ms) represents the system frequency response. Tweeter decay time is good, but there is a strong delayed woofer resonance mode at 1830Hz beginning at about 0.75m. A ridge due to the woofer peak shown in *Fig. 7* also appears at about this time.

## WOOFER/TWEETER TIMING

SL-60 step response shown in *Fig. 3* indicates that tweeter output arrives at the test mike before woofer response. *Figure 9A*, which shows a better view of this behavior, is a plot of excess group delay versus frequency referenced to the tweeter's acoustic phase center. This is a plot of signal delay in mil-

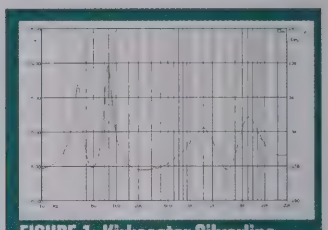


FIGURE 1: Kirksaeter Silverline SL-60 impedance.

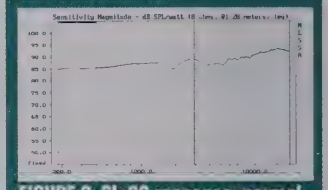


FIGURE 2: SL-60 response: normal (dotted), tweeter reversed (solid).

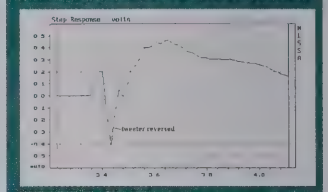


FIGURE 3: SL-60 step response: normal (dotted), tweeter reversed (solid).

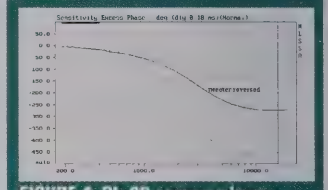


FIGURE 4: SL-60 excess phase: normal (dots), tweeter reversed (solid).

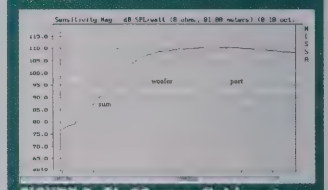


FIGURE 5: SL-60 near-field port and woofer (dotted), their sum (solid).

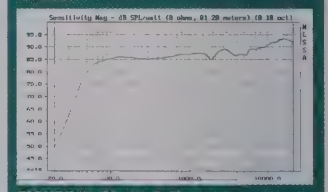


FIGURE 6: SL-60 full-range frequency response.

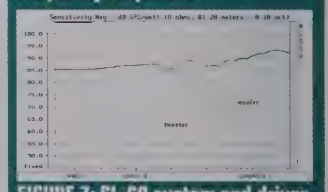


FIGURE 7: SL-60 system and driver responses on expanded scale.

liseconds versus frequency. (A detailed description of excess group delay can be found in reference 1.) In a time-coherent system this plot would be a flat line.

Above 10kHz excess group delay is essentially zero because it is referenced to the tweeter arrival time in this frequency range. The curve rises gradually below 10kHz, reaching a plateau below 1kHz of 161µs, or 0.161ms. This plot shows that over its operating frequency range, the woofer is 161µs behind the tweeter. Both drivers are connected with positive polarity (using the reversed tweeter connection), but the system is not time-coherent.

*Figure 9B* shows SL-60 excess group delay with the tweeter in its normal connection. With this connection, signal delay in the crossover region exceeds 0.8m. This level of delay will cause gross waveform distortion.

## POLAR RESPONSE

Polar response is examined in *Figs. 10* and *11*. *Figure 10* is a waterfall plot of horizontal polar response in 10° increments from 60° left (–60°) to 60° right (+60°) when facing the speaker. All off-axis plots are referenced to the on-axis response, which appears as a straight line at 0.00°. Thus, the plotted curves show the *change* in response as you move off axis. For good stereo imaging the off-axis curves should be smooth replicas of the on-axis response, with the possible exception of some tweeter rolloff at higher frequencies and larger off-axis angles.

You can see the expected rolloff of tweeter response at higher frequencies and larger off-axis angles. This performance is fairly typical of 25mm dome tweeters. *Table 1* lists the horizontal off-axis responses at 15kHz and all angles up to ±60°. Below 8kHz horizontal coverage is fairly broad. There is a mild response dip below the crossover frequency and at angles beyond ±30°. Again, this is fairly typical of two-way systems.

**TABLE 1**
**HORIZONTAL POLAR RESPONSE AT 15KHZ**

| ANGLE | RESPONSE (DB) |
|---|---|
| 10 | –0.6 |
| 20 | –2.5 |
| 30 | –4.6 |
| 40 | –6.9 |
| 50 | –9.6 |
| 60 | –10.8 |

The average response over a 60° horizontal angle (±30°) in the forward direction is shown in *Fig. 11*. Peaking of the average forward response above 10kHz is reduced somewhat relative to the on-axis response. This may make the audible effect of the peaking less apparent since the human ear integrates direct and reflected sound when judging the overall spectral balance of a loudspeaker.

*Figure 12* is a waterfall plot of vertical polar response. Responses are shown in 5° increments from 20° below (–20°) the tweeter axis to 20° above it. Response changes very little as you move below the tweeter axis.

The worst-case change at 20° below the tweeter axis is only –4.4dB. However, response changes rapidly beyond 5° above the tweeter axis. At +20°, response dips 19dB at 2880Hz. For broadest vertical coverage the SL-60 should be tipped back about 10°. (Alternatively, listeners can lie on the floor.)

## INTERMODULATION DISTORTION

Next I measured intermodulation distortion. In this test two nearby frequencies are input to the speaker. Intermodulation distortion produces output frequencies that are not harmonically related to the input and are much more audible and annoying than harmonic distortion. Let the symbols $f_1$ and $f_2$ represent the two frequencies used in the test. Then a second nonlinearity will produce intermods at frequencies of $f_1 \pm f_2$. A third nonlinearity generates intermods at $2f_1 \pm f_2$ and $f_1 + 2f_2$.

I examined woofer intermods first by inputting 900Hz and 1kHz signals at equal levels. These frequencies should appear predominantly in the woofer output. I adjusted total SPL with the two signals to 85dB at 1m. I usually run IM distortion tests at 90dB SPL. However, because steady tones are used in the IM test, I thought it safer with this small monitor to use a lower power level.

The SL-60 system output spectrum for this test is shown in *Fig. 13*. The two largest spectral lines represent the input signals. There are ten distinct IM distortion products. The largest is third-order at 1100Hz and is 48.6dB below the main output, which is equivalent to 0.37% distortion.

Total IM distortion is approximately 0.55%. Although the overall level is not that high, the multiplicity of distortion products is troubling. I suspect the ferrite core coil used in the woofer crossover causes this behavior.

I measured tweeter intermods with a 10 and 11kHz input pair also adjusted to produce 85dB SPL at 1m (*Fig. 14*). The only significant IM product at 12kHz is 54dB below the main output at 0.02%, which is a very low level of distortion. However, the spectral lines at 10 and 11kHz do not drop immediately into the noise level; rather, there is a broadening of the spectrum at the base of the lines. This is possibly caused by mechanical noise in the tweeter suspension, and is a form of spectral contamination. I look to the reviewer for any possible consequences of this noise.

*(continued on page 61)*

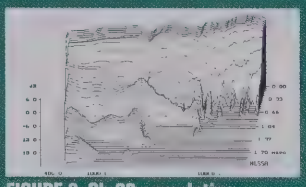


FIGURE 8: SL-60 cumulative spectral decay.

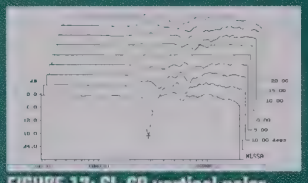


FIGURE 12: SL-60 vertical polar response.

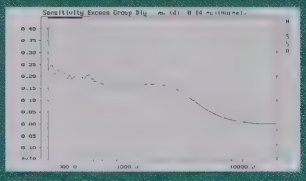


FIGURE 9A: SL-60 excess group delay: "reversed" tweeter connection.

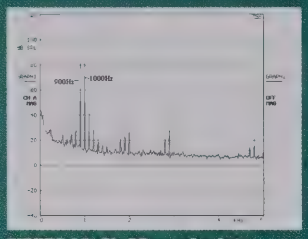


FIGURE 13: SL-60 woofer intermodulation distortion.

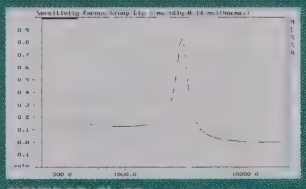


FIGURE 9B: SL-60 excess group delay: "normal" tweeter connection.

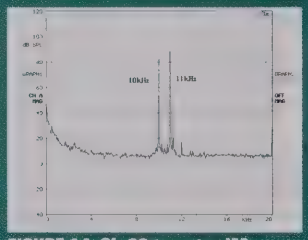


FIGURE 14: SL-60 tweeter IM distortion.

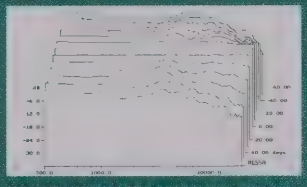


FIGURE 10: SL-60 horizontal polar response.

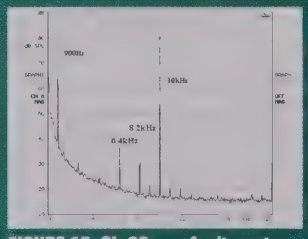


FIGURE 15: SL-60 woofer/tweeter IM test.

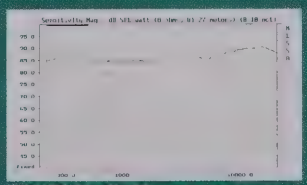


FIGURE 11: SL-60 average response over ±30°.

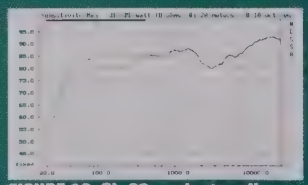


FIGURE 16: SL-60 against wall (solid), free-stand (dotted).

Reviewed by Rita and Dennis Colin

## DESCRIPTION

Two-way mini monitor, 5″ woofer, 1″ titanium dome tweeter, ported enclosure. Price $698. Available from Kingcaid Acoustics, 1943 Linden Lane, Hatfield, PA 19440, 215-361-1559, FAX 215-361-8908. Unlike most speakers, these are meant to be placed against a wall (no more than 2″ away); they are reportedly used in recording studios, wall-mounted above the mixing console.

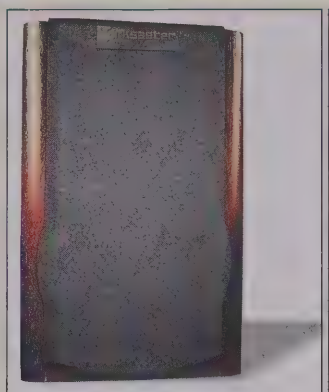


**PHOTO 1:** SL-60 with grille.

**PHOTO 2:** Back view.

## EQUIPMENT AND SETUP

We used a Nakamichi AV-1 receiver (100W/ch) and a Yamaha CDC 755 CD changer. While not a $90,000 analog tube setup, the fidelity is good enough to evaluate excellent loudspeakers.

The listening room is approximately 20′ × 18′ × 8½′ (3000ft$^3$), moderately damped with stuffed chairs, drapes, and carpet, and well-dispersed by numerous openings. Many other speakers sound excellent with this setup, including the Swans M1 ("Test Drive" in *SB* 3/99, p. 36). We mounted the SL-60s against a long wall, about 8′ apart, with tweeters at seated ear height (3″).

**PHOTO 3:** Putting the woofer and tweeter drivers in place.

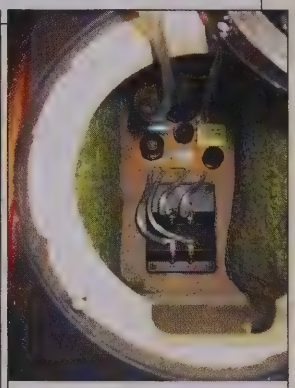


**PHOTO 4:** Cable connections inside the SL-60.

## SOURCE MATERIAL

Per Ed Dell's request, we used the *Hi-Fi News and Record Review* Test Disc CD, tracks 2, 4, 5, 6, 7, 10, and 14. We also listened to a variety of other material we're familiar with, including:

- *Blue*, Le Ann Rimes, Curb D4-777821
- *Tango*, Julio Iglesias, Columbia/Sony CK 67899
- *Marches in Hi-Fi*, Fiedler/Boston Pops, RCA 09026 6149-2
- *Ocean Front Property*, George Strait, MCA MCAD-5913

To break in the unit, I applied a bass-boosted pink-noise signal, about 1W average, >10W peak for six hours.

## THE KIRKSAETER SOUND

Unfortunately, it has one. With every piece of source material, both of us immediately and strongly noticed a suppressed upper midrange and an extremely bright treble response. Suspecting an out-of-phase tweeter connection, I reversed the bi-wired tweeter feeds. There was some reduction of the hollow "suckout" sound, but the same basic thin and tinny sound remained.

Next, I moved the speakers out into the room and noticed little difference (somewhat less lower bass, somewhat smoother mid-bass, but same basic character). So I replaced them against the walls.

## SOME COMMENTS

1. Female voices sound 100′ away, no presence.
2. Male voices sound like marbles with a lisp.
3. Drums sound brittle, no solidity.
4. Saxophone sounds hollow, missing "warmth" harmonics.

Now, I don't mean to be unkind, but this pronounced tonality simply overwhelmed our experiences, making any good aspect, such as smooth extended bass (maybe 50Hz) and good imaging, difficult to appreciate.

5. Bass sounded smooth, well-damped, and extended to about 50Hz.
6. Stereo spread, soundstaging, and ambience were sometimes very good. The positioning of the narrator and instruments in "Peter and the Wolf," for example, was natural-sounding. But the exaggerated highs sometimes seemed to cause excessive stereo spread, particularly on *Marches in Hi-Fi*.
7. Distortion sounded excessive above moderate levels.

I think the drivers in this system are inherently good, with smooth response free of audible resonance. Also, the woofer response itself seems good. (We listened with the tweeters disconnected; what came out sounded normal for such a test.) Therefore, this speaker may be of interest to those who enjoy crossover design; the cabinet and drivers appear to be of sufficient quality to enable you to achieve high-quality sound with the right crossover.

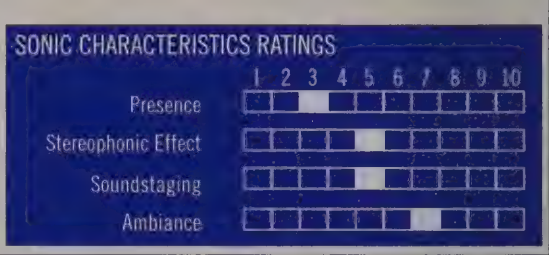
## COMMENT ON JOE'S MEASUREMENTS

I've never heard measurements speak louder!

1. The frequency responses are exactly what we heard.
2. The distortion anomalies (re other speakers) that Joe mentioned–both the high order of low-frequency IM and the broadband high-frequency "noise pedestals"–may have contributed to our rapidly developed sense of "ear fatigue," or intolerance of the sound.
3. The lower-midrange dip caused by wall mounting, while audible, didn't significantly change the speakers' basic tonality. Apparently the Haas (precedence) effect informs the ear as to a sound source's basic nature even with close reflections (in this case about 1ms). This shouldn't be surprising, since our hearing has over 120dB range, and can discriminate over 4000 discrete frequencies in less than 1 cycle of whatever frequency while separating dynamic spectral structures in as fast as perhaps 0.1ms.
4. In spite of the preceding, the speakers sounded most like Joe's wall-mounted frequency response; it's just that the wall-induced effect was nowhere as objectionable as the CO dip and extreme HF rise. So I fully agree that the single most significant indicator of loudspeaker sound quality is the direct, first-arrival, on-axis frequency response.

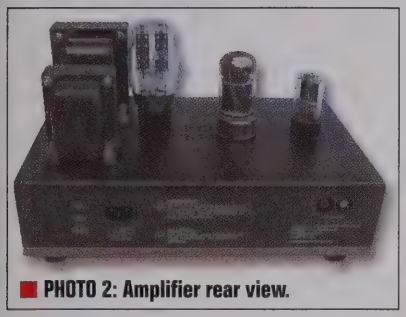
Other factors will influence the sound, of course, but nothing can completely conceal or compensate a significantly non-flat primary response. After all, the human race has been practicing sound-source-nature determination for many millennia. We're only here because some of our predecessors had developed the ability to hear quickly the presence of an approaching tiger; those who didn't quickly became cat food!

| TECHNICAL DATA | SILVERLINE 60 |
|---|---|
| Type of speaker: | Mini bookshelf-Satellite |
| Music peak power: | 120W peak |
| Music impulse power: | 80W peak to peak |
| Continuous power rating, DIN: | 45W |
| Frequency response: | 45-25,000Hz |
| Recommended amplifier: | 20-40W |
| Crossover Frequencies: | 2.500Hz, double 2-ways |
| Impedance: | 4-8Ω |
| Woofer, long excursion: | 15cm coated fiber cone |
| Midrange: | none |
| Tweeter: | 25mm soft metal dome |
| Weight net: | 5kg, 11 lb |
| Width × Depth × Height in cm: | 19 × 25 × 29.5cm |
| Width × Depth × Height in inch | 7.5″ × 10.5″ × 11.5″ |
| Black/solid glossy Mahogany | Black/Mahogany décor strips |



# Wheatfield Audio HA-2 Headphone Amp

*Reviewed by Charles Hansen & Betty Jane & Richard Honeycutt*

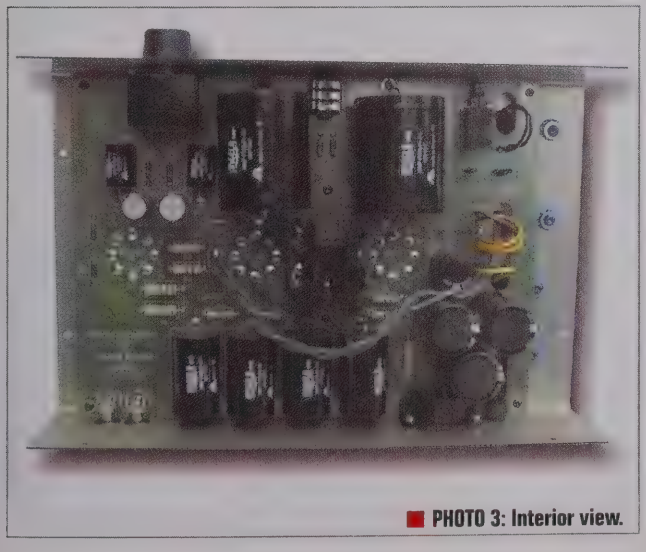


■ PHOTO 2: Amplifier rear view.

■ PHOTO 1: Amplifier front view.

*Wheatfield Audio LLC, 21715 W. 29th St. N., Andale, KS 67001, 316-641-6201, www.headphoneamp.com, e-mail pete@headphoneamp.com. Distributed by HeadRoom (800-828-8184, www.headphone.com). $695. Dimensions: 13″ W × 8.5″ D × 8″ H (including tubes); net weight: 16 lbs. Limited one-year warranty (tubes 6 months).*

The HA-2 is distributed by HeadRoom, a manufacturer of solid-state headphone amplifiers. I used a HeadRoom module in my preamplifier project (*AE* 6/97, p. 8), so I was curious to see how it compared with the HA-2. I use Grado SR-125 headphones (32Ω), so I needed to borrow a pair of 270Ω Sennheiser headphones to match the minimum 100Ω impedance required by the HA-2.



■ PHOTO 3: Interior view.

## CONSTRUCTION

The Wheatfield Audio HA-2 is a single-ended tube headphone amplifier. *Photo 1* shows the front panel, which has the volume control, ¼″ headphone jack, and push-button power switch. There are no LEDs. Only the glow of filament and heaters serves as a power-on indicator.

The volume control has an expanding sweep graphic silk-screened on the black-painted aluminum chassis. Two oak strips sit beneath the chassis in which the rubber feet are mounted. Holes are provided around the tubes, on the bottom plate, and at both sides to enhance cooling.

The rear panel (*Photo 2*) includes a power fuse post, the IEC power receptacle, and a pair of cadmium-plated RCA input jacks. The third pin of the AC receptacle is connected to the chassis. Since the HA-2 has only a single set of input jacks—without pass-through output jacks—you must dedicate your audio source to it. Another alternative is to connect the HA-2 to your preamp tape loop.

*Photo 3* shows the amplifier with the bottom cover removed. All the circuitry is mounted on a large PC board with heavy ground traces. The only wiring is from the power transformer and choke to the circuit board.

The unit is furnished with a heavy power cord. Workmanship is first-rate. The film capacitors are potted Angela MKP polypropylene, and the electrolytics are Panasonic and Elna Cerafine, while the resistors are Riken-ohm carbon film, and the tube sockets are silver-plated.

## TUBE-POLOGY

The HA-2 circuitry is similar to a cathode-follower output preamplifier, except that the output impedance is low enough to drive headphones. The selected input

signal is applied to an Alps Black Beauty 100k dual audio pot. The wiper for each channel is connected to the grid of half a 6SN7 triode. The plate of the first stage is connected directly to the grid of a 6AS7 second stage, which is configured as a cathode follower, so the output is inverted.

The cathode sits at +190V DC and is loaded with a 2k 20W TO-220 power resistor mounted on a hefty finned heatsink. The AC output signal is coupled to the output jack through a 47µF capacitor loaded with a 4k7 output resistor. There is no global feedback.

Wheatfield recommends that the headphone impedance be 100Ω or higher to avoid higher distortion levels. That eliminates the Grado line, which has 32Ω nominal impedance. The power supply is full-wave rectified by a 5U4 and applied to a capacitor-choke pi-filter. A 6.3V AC winding, with two grounded fixed resistors to null the hum, powers the triode heaters.

Wheatfield Audio supplied the following tube complement with the review HA-2:

- Russian National Electronics 6SN7GT
- G.E. JAN 6080WC (6AS7G)
- Sovtek 5U4G

## MEASUREMENTS

I installed the tubes and ran both channels with pink noise at 1V RMS for one hour into 270Ω. The unit runs fairly hot—more like a power amplifier than a preamp. The input impedance measured 91k. The output impedances for both channels measured 145Ω at 1kHz, and the HA-2 inverts polarity.

The HA-2 showed unity gain into 270Ω when the volume control was set at approximately 1 o'clock. I made all the measurements at a volume setting corresponding to 1V RMS output with a 0.5V RMS test signal (6dB gain). There was a very low level of hum in the headphones, independent of the volume control setting. There was no additional sound during either power-up or shutdown.

I recorded the response for loads of 620Ω, 270Ω, 100Ω and, out of curiosity, at the 32Ω load represented by Grado headphones. Remember that this low a load, while not harmful, is not recommended. The 47µF output coupling cap will roll the low frequency off –3dB at $f = 1/(2\pi RC)$.

The HA-2 frequency response measured within ±3dB from 5.5Hz to 60kHz, with 0dBr defined as 1V RMS at 1kHz into 620Ω, and –1dB down at 10Hz. When I decreased the load to 270Ω, the –3dB point rose to 8.5Hz. At 100Ω, –3dB crept up to 14Hz. As expected, with 32Ω it was down –3dB at 17Hz. This indicates that the actual value of the output coupling cap was higher than nominal, with very low ESR. High-frequency response rolled off gradually above 30kHz, and was down –3dB at 61kHz regardless of load, with no additional HF gain peaking.

The HA-2 provides a maximum of 16.8dB gain with a 620Ω load. Full-volume gain decreased to 14.8dB with 270Ω, and to 11dB for a 100Ω load. Volume control tracking was excellent, with no measurable difference for output voltages from 50mV to 2V RMS.

The HA-2's square wave response was very good. The 1kHz and 10kHz response showed a very slight rounding of the leading edges, with no tendency toward peaking or ringing. The 40Hz square wave showed some tilt, which increased as the load decreased, as a result of the limited low-frequency response caused by the output coupling capacitor.

## DISTORTION

As with most tube gear, the HA-2 never really goes into hard "brick wall" clipping. The peaks of the waveform are softly compressed with increasing output voltage. Distortion does increase with decreasing load, however. The left-channel distortion was higher than the right, and is presented here and in *Table 1*.

The CCIF intermodulation distortion (19 + 20kHz) at 2.84V pk-pk into 620Ω was a low 0.007%. As I decreased the load to 270Ω, then 100Ω, the IMD increased to 0.36% and 0.97%, respectively.

*Figure 1* shows THD+N versus output voltage into various loads at 1kHz, including the not recommended 32Ω and an open circuit (100k test instrument input impedance). Interestingly, the THD+N curves at 20Hz and 20kHz (not shown) were essentially the same as the 1kHz curves at each load. I engaged the test set 80kHz low-pass filter to limit the out of band noise. The 1% THD+N clipping voltage was 10.2V RMS for 620Ω, 4.27V RMS for 270Ω, and 0.95V RMS for 100Ω. Based on the residual distortion waveform I observed, power-supply hum and

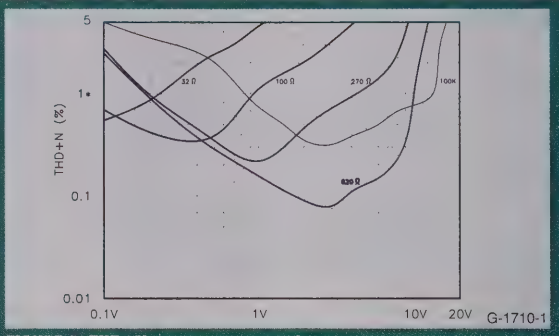



**FIGURE 1: THD+N versus output voltage.**

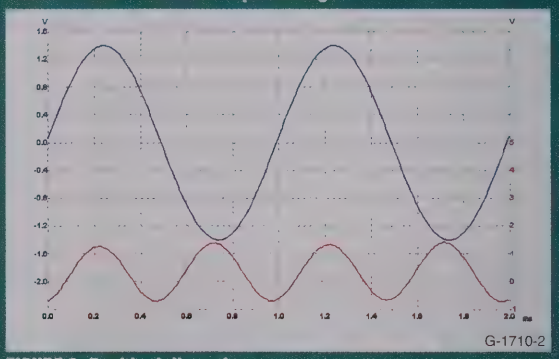



**FIGURE 2: Residual distortion.**

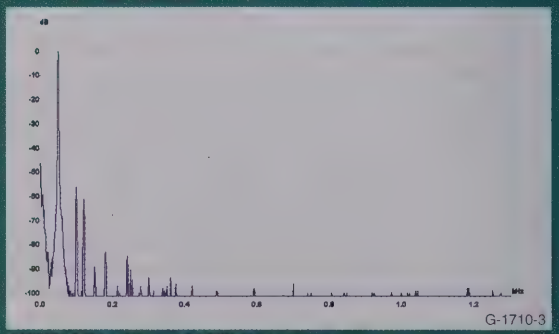



**FIGURE 3: Spectrum of 50Hz sine wave.**

**TABLE 1**
**MEASURED PERFORMANCE**

| PARAMETER | MANUFACUTURER'S RATING | MEASURED RESULTS |
|---|---|---|
| Output impedance | 100Ω | 145Ω |
| Maximum output level (1kHz, 5% THD) | 620Ω load: 13V RMS, 36V pp<br>270Ω load: 10.5V RMS, 30V pp | 12.5V RMS<br>9.4V RMS |
| Maximum output power (1kHz, 5% THD) | 620Ω load: 270mW<br>270Ω load: 400mW | 252mW<br>327mW |
| Total harmonic distortion + noise (1kHz, 1V RMS output) | 620Ω load: <TBD% (sic)<br>270Ω load: <TBD% (sic)<br>100Ω load: N/S | 0.16%<br>0.22%<br>1.1% |
| Voltage gain | 620Ω load: 17dB<br>270Ω load: 15dB<br>100Ω load: N/S | 16.8dB<br>14.8dB<br>11.0dB |
| Frequency response (±3dB) | 620Ω load: 10Hz–75kHz<br>270Ω load: 15Hz–75kHz<br>100Ω load: N/S | 5.5Hz–61kHz ±3dB<br>8.5Hz–61kHz ±3dB<br>14Hz–61kHz ±3dB |
| Ripple and noise | <3.5mV RMS | 1.9mV RMS |
| IMD-CCIF (19 + 20kHz) | N/S | 270Ω load: 0.36% |
| Input impedance | N/S | 91k |
| Power requirements | 100W | |

some HF noise dominate the readings at low levels.

The distortion waveform for 1V RMS into 270Ω at 1kHz is shown in *Fig. 2*. The upper waveform is the amplifier output signal, and the lower waveform is the monitor output (after the THD test set notch filter), not to scale. This distortion residual signal is the second harmonic, with a low-level higher frequency riding on the waveform. THD+N at this point is 0.22%.

The spectrum of a 50Hz sine wave at 1V RMS into 270Ω is shown in *Fig. 3*, from zero to 1.3kHz. The THD+N again measured 0.22%, with the second harmonic measuring –56dB. The few higher harmonics present are all below –90dB. There are some power-line-related harmonics: 120Hz at –61dB, and 180Hz and 240Hz at about –85dB. ❖

*(mfg. response on page 62)*

## CRITIQUE

**Reviewed by Betty Jane and Richard Honeycutt**

I believe it is in Derek Williamson's *The Complete Book of Pitfalls* that those young men who would impress their girlfriends with their stereo systems are advised to follow certain rules, including having at least one box with glowing tubes on top and a large knob on front. Wheatfield Audio has passed that test. The physical appearance of their HA-2 headphone amplifier is classic, to use the company's own words.

For old audio buffs like myself, certain warm fuzzies accrue from just plugging the tubes into the beautiful ceramic sockets, then turning on the set and seeing the glow. The solid feel of the chassis and the almost inaudible sound from the transformer vibrating the chassis also add to the familiarity. (The manufacturer uses synthetic vibration isolators to mount the power transformer in order to minimize mechanically generated buzz—an extra touch of quality!)

With that said, I must state that after 30 years of professional listening as musician, recording engineer, radio station engineer, and designer of loudspeakers and sound systems, I have learned that you must be especially careful how you listen if you are to hear what's there, rather than what you expect. I have learned that listening to just one product by itself will reveal obvious defects, but not much more. In comparative listening, it has been proven that a 1dB difference in level between two signals is not perceptible in terms of loudness, but will influence the vast majority of listeners to prefer the sound of the louder source. (This is an example of the Fletcher-Munson curve, in case you're interested.)

### TESTING

In order to audition the HA-2 fairly, I set up an A/B box, connecting my CD player to both the HA-2 and a Sony TCWR565 cassette recorder. (The Sony has an integrated-circuit headphone amplifier that measures ruler-flat over a frequency range greater than that of my headphones). I fed the headphone output of the Sony to one input of the A/B box, and the output of the HA-2, to the other.

Then I played the 0dB, 1kHz reference tone on the *Hi-Fi News* test CD and trimmed the input level control of the Sony to balance the channels and to set the output at the reference level of the tape recorder. Finally, I set the output levels on the Sony and the HA-2 to provide 200mV at the output of the A/B box, while the output was feeding a set of Jensen 200 professional headphones. Output levels from the two sources were matched within 0.1dB.

The actual tests occurred with each of us working independently, listening to the tracks on the test CD while flipping the switch at will. We recorded our responses according to switch position A or B, and did not check which switch position corresponded to which source until the test was completed. Thus it was a blind A/B test.

In order to eliminate any "equipment bias" that might have resulted from a contaminated connector or switch contact, we swapped plugs after completing the tests and listened to track 1 again. We were able to correctly identify which switch position corresponded to the former "source A," thus proving that the differences we heard were not due to artifacts of the A/B box.

Only after each of us had completed the test did we identify which source corresponded to which switch position, and only then did we compare our results. Here is what we heard, identified by program material and listener initials. Please bear in mind that all the differences we heard were very slight, sometimes requiring many flips of the A/B switch to be sure.

### TRACK 1—"LA REJOUISSANCE"/HANDEL

**BJH:** No discernible difference.
**RH:** The brass may have been slightly better defined on the control amplifier, but it was a close call. (Personal opinion: the arrangement and recording on this track overdo the percussion and fireworks noises for effect, making musical judgments difficult. The Jean-Francois Paillard recording on MHS 511 is superior. Familiarity with it could well have biased our expectations on this track.)

### TRACK 2—"JERUSALEM"/PARRY

**BJH:** No discernible difference.
**RH:** Voices may have been a bit better defined on the control amplifier.

### TRACK 3—"HENRY V" EXTRACT/DOYLE

**BJH:** No discernible difference.
**RH:** No discernible difference.

### TRACK 4—"TRUMPET CONCERTO IN C"/VIVALDI

**BJH:** No discernible difference.
**RH:** No discernible difference.

### TRACK 5—"PETER AND THE WOLF"/PROKOFIEV

**BJH:** No discernible difference.
**RH:** If there was a difference to be heard anywhere, it was on this track. Note the "if," though. Any difference was still quite subtle. But the voices, clarinet, and strings seemed ever so slightly fuller on the control amplifier, and the inner voices a bit more detailed. The trumpet may have had a very slight edge on the HA-2.

### TRACK 7—"WELCOME, WELCOME"/PURCELL

**BJH:** No discernible difference.
**RH:** The inner voices may have been a bit more detailed on the control amplifier.

### TRACK 8—MAHLER 8, "GLORIA PATRI DOMINO"

**BJH:** No discernible difference.
**RH:** Extreme highs may have been a bit more natural on the control amplifier.

### TRACK 15—XYLO: PEOPLE WHO HIT THINGS, "THE WHISTLER"

**BJH:** No discernible difference.
**RH:** Higher pitches on the xylophone were better-defined on the HA-2, and the attack of the xylophone slightly better.

### FINAL COMMENT

You have likely noticed that Betty Jane could hear no difference between the two amplifiers. In fact, she was incredulous that I claimed to hear some slight differences! And I cannot be certain about the differences I have listed, because they are so very subtle.

All the effects noted were very slight, and would not have been found without the ability to A/B two sources. Even with that ability, the two amplifiers sound so alike that comparisons were difficult. What this means is that the HA-2 is an excellent amplifier, quite neutral and uncolored, and adds almost no discernible artifacts (hum, noise, distortion) to the music.

In fact, most engineers who have studied the comparison between the vacuum-tube sound and the solid-state sound agree that real differences show up only when the active devices are overdriven, assuming good design. Overdriven ICs sound horrible. Overdriven discrete transistors can be less objectionable, depending upon the implementation of negative feedback. Overdriven vacuum tubes are much more sonically pleasing.

We did not test either amplifier while overdriving it because we value our hearing. Without the whole-body clues that are available during non-headphone listening, it is quite easy to turn headphones up to damaging levels unintentionally.

The bottom line, in our opinion, is that you should carefully evaluate the combination of your headphones and any headphone amplifier you may purchase, and then buy the one that sounds good to you. For quality construction and excellent performance in a well-designed vacuum-tube unit, the Wheatfield HA-2 certainly deserves serious consideration.

# An SE 6AS7G Design

*Here's an amp story with a twist. It stars a familiar character—the 6AS7G—but in a different role.*

**BY GEORGE J. DAVID**

Can *GA* readers stand another 6AS7G story? —perhaps not if it is of the garden-variety push-pull circuit type. This one is different and it sounds great. Notice I said it sounds great. I didn't say it had low harmonic content, nor will I make any claims as to its technical performance.

I know you are going to say, "How great is great"? Well, I have two 2A3s connected in the parallel choke-fed configuration, and they sound superb. There isn't much around that can beat them. This 6AS7G amp is almost as good as the 2A3s, and it's definitely better than a pair of 5881s connected in an ultralinear push-pull configuration.

## BACKGROUND

The rise in popularity of the single-ended amp lies in the fact that the average listener thinks it sounds better than the time-honored push-pull amp. Why? Because the single-ended amp has harmonic (especially the second) production.

This amp will drive most speakers to good volume in an average-sized room. You must be careful not to overdrive it. I have selected the preamp stages with this in mind so that the amp will generally stay in Class A.

This amp is in my right stereo channel, while my left channel contains a pair of 2A3s with similar circuitry. It is difficult to hear any difference in the music coming from either amp. The 2A3s sound more mellow, and the 6AS7Gs sound more sharp and firm.

## CIRCUIT

The first two stages come from the *RCA Tube Manual* and use a good old cascaded 6SN7 (*Fig. 1*). The third stage is unusual in that I parallel the two sections of a 5687. The cathode circuitry on this tube ensures that the sections are balanced.

The use of a paralleled tube may appear extreme, but I need plenty of power available since I am using most of it in the 40k carbon noninductive grid resistor on the two 6AS7Gs. Using most of the power in this resistor and only a fraction in the 6AS7Gs provides stability in my drive. It also reduces the possibility of either stage affecting the other.

Note the use of a bass control on the 6SN7 second stage. I think everyone likes to adjust the bass to their liking and this


**ABOUT THE AUTHOR**

George J. David earned a BSEE degree from the University of Nebraska. He worked for four years with power generation at Joseph E. Seagrams and four years as a design engineer at Western Electric. He has spent 30+ years working with industrial automation and is a member of the ARRL.

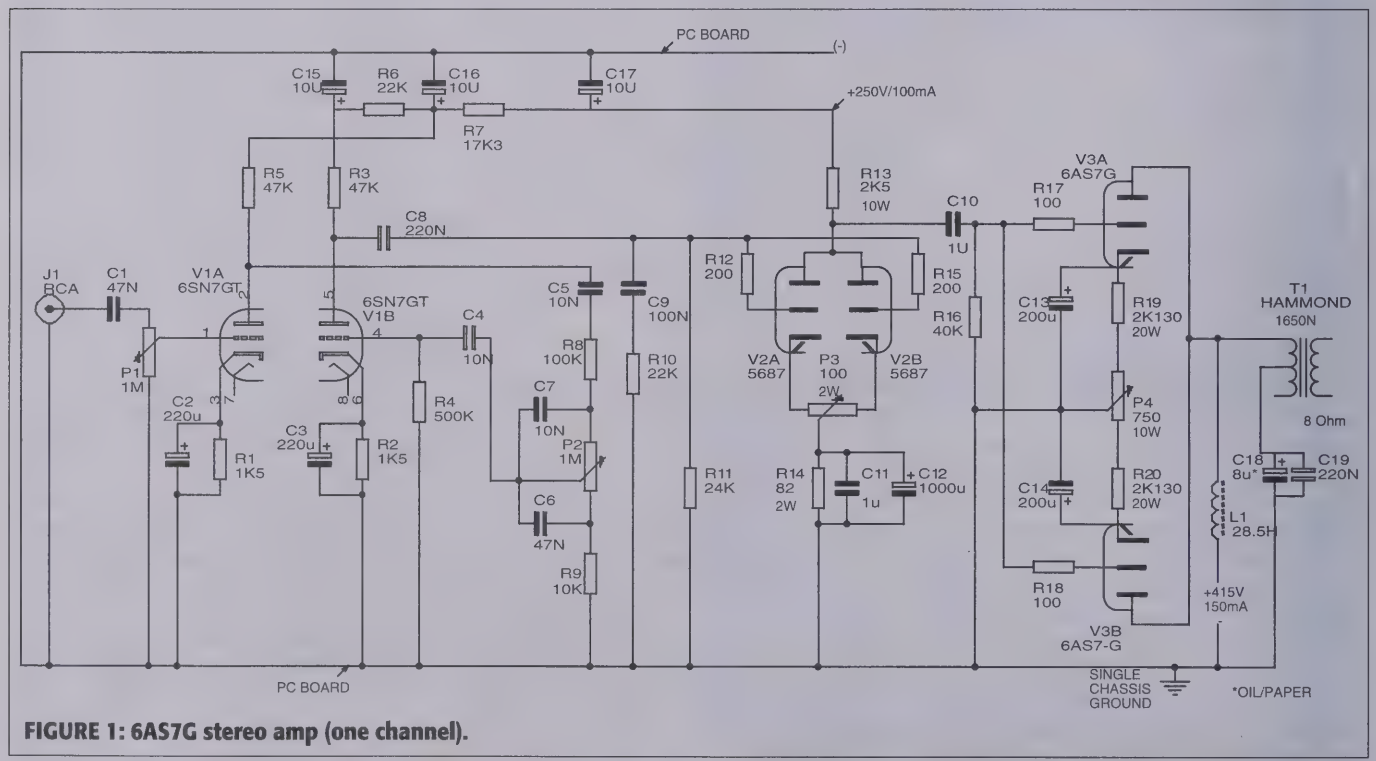



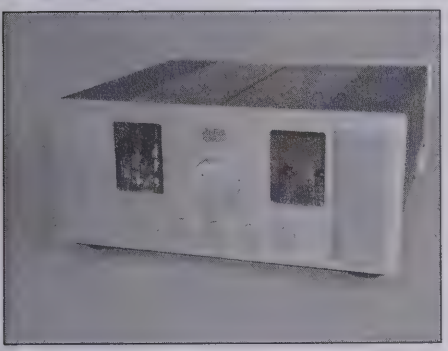

**FIGURE 1: 6AS7G stereo amp (one channel).**

# Luminous 1.0

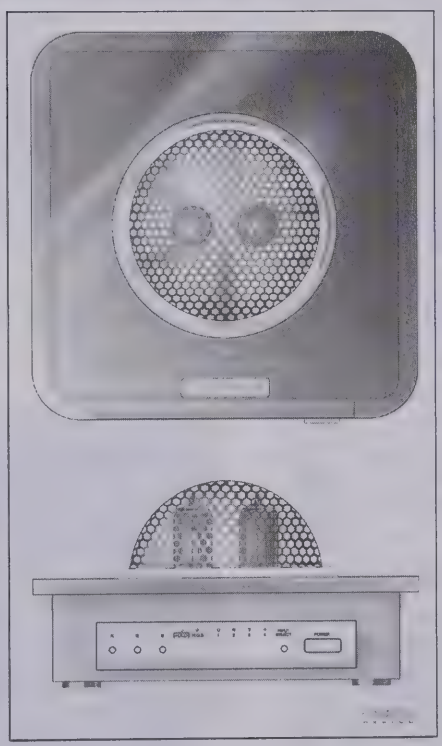
## Debut!!

**You should wait for exchange your old CD Players**
**Because you will have a good result with our Luminous1.0**
**Twin output stages MOS-FET and Tubes**
**HDCD® 24Bit96kH**
**Top panel luminous RGB 14,770,000 colors**

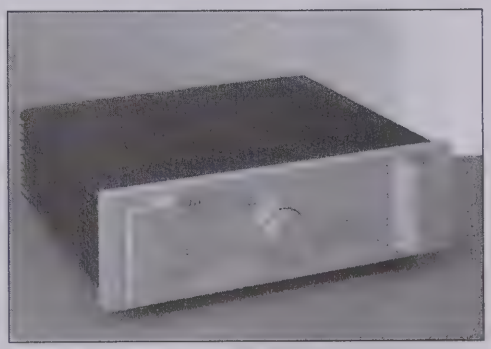
# See you at WCES 2001



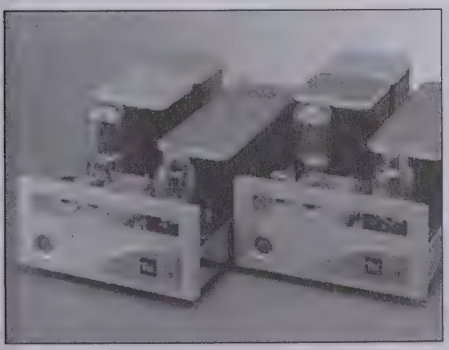
88 Signature



Luminous 1.0



TR 1



845 Signature

Heat Wave

Triode Supply Japan Ltd.
1-23-1 Kitakoshigaya Koshigaya-shi Saitama Japan
tel:+81-489-78-7109 fax:+81-489-78-7309
http://www.triode.co.jp/ e-mail:infow@triode.co.jp

control provides a range of ±10dB. It also allows you to compensate for bass lost at low frequencies in the chokes supplying the 6AS7Gs. Those chokes look like 11kΩ at 60Hz, while at 1kHz they look like 180kΩ. I am also chopping off some of the highs and adding more stability to the driver stages by installing R10 and C9 between the 6SN7 and the 5687.

In preparation for the final stage, I use a pair of 6AS7Gs in separate envelopes. I use only one triode in each tube. I do this because I found that only one section was good in the many used 6AS7Gs I acquired, while the other section was almost always bad. Note the cathode balancing method for these tubes, which is a must.

In this single-ended amp version, I get away from output tranny problems by not passing a DC current through the transformer. The output tranny handles only audio. The tubes get their DC current through the 28.5H choke.

The bigger the choke the better. More reactance in the choke provides less attenuation of the low frequencies. Use chokes with low DC resistance and with the ability to carry at least 150mA. You don't wish to risk having saturation in these chokes. I obtained the 28.5H of choke by putting three chokes in series, which I picked up at a flea market.

## COMPONENTS AND CONSTRUCTION

I am using a Hammond type-1650N output transformer. The primary is for a push-pull amp and is rated at an impedance of 4300. By using only one half of the primary, I get an impedance of 1075, which does a nice job on these tubes. It's a little high, but I lose very little power and get some reduction of harmonic output.

The tubes are dealing with less than 1075Ω because, from an AC standpoint, the chokes and the output tranny are in parallel. The chokes slightly reduce the effective reactance.

I am using two power supplies. One provides 400–425V at 150mA to the chokes and should have at least 150µF of capacity across its output. This lowers the impedance of the supply. A regulated supply would be nice, but is not necessary. The second supply provides 250V at 100mA to the preamp stages. This supply should be terminated with 120µF of capacity.

I am using DC on all of the tube filaments. This assures freedom from filament-generated AC hum. I expect, however, that with all of these tubes having cathodes separate from the filament, very little hum would be experienced if you used AC.

Separate the amplifier grounds from the chassis grounds. I use a piece of single-sided copper board laid on top of the chassis. I tie all amplifier grounds to this and ground it to the chassis at only one place.

6AS7G tubes are inexpensive and are available both new and used. You could use a 6SN7 in place of the 5687 without much difference in performance. I, however, prefer the 5687. ❖

**GLASS AUDIO**

Encourages reader feedback in the form of letters, queries, and comments. Send correspondence to:

Glass Audio
Editorial Dept., PO Box 876
Peterborough, NH 03458-0876
FAX (603) 924-9467
E-mail editorial@audioxpress.com

Be sure to reference the issue, author, and page number of the article or letter in question, and, if you request a response, please include a self-addressed envelope (or FAX number and E-mail address, as applicable) with a loose stamp or postal coupon.


# Antique Sound Lab.

## Unbelievable Value, Vast Selection & Superb Sound

Superbly designed and built tube audio components to satisfy value conscious audiophiles with discriminating tastes.

Several amplifiers based on 845, 805, 6C33, 300B etc... Output tubes.

All tube preamplifiers with phono stage.

Divergent Technologies Inc.
www.divertech.com
342 Frederick St.
Kitchener Ontario
Canada, N2H 2N9
Phone: 519.749.1565 Fax: 519.749.2863

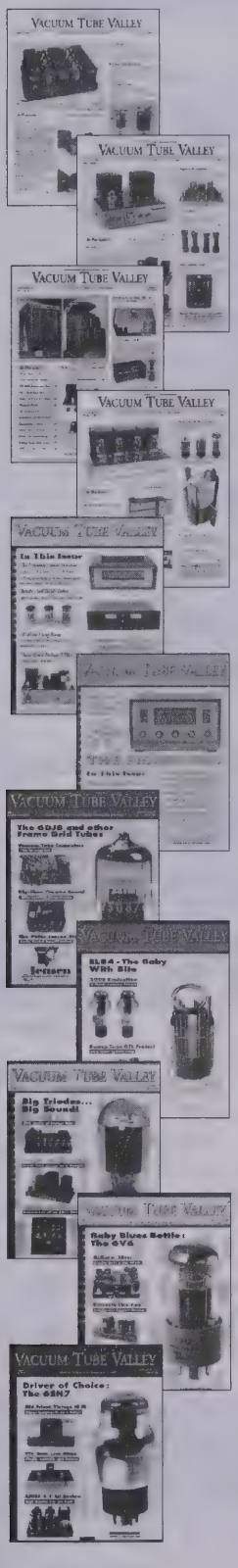
$599.00 US Retail

MG SI15 DT edition
KT88 Based 15Wx2 SET integrated amplifier

Reader Service #107

# VACUUM TUBE VALLEY

## Back Issues, Books, Goodies, & Subscriptions



**VTV #1 Spring 1995** *$12.95*
Vintage Dynaco Tube Equipment - 1955-77
History and Testing of the 12AX7/ECC83 dual triode
Tube Testing Methods + Early Amplification and Amps

**VTV #2 Fall 1995** *$12.95*
Heathkit - The Tube Williamson Years 1950-61
EL34/6CA7 History, Types and Tests
Magnum SE EL509 Amplifier Project by Dave Wolze
1927-34 Western Electric Theater Sound Systems

**VTV #3 Winter 1995/96** *$12.95*
Eico Mono Tube Gear - 1955-62
Altec Lansing 604 Coaxial Loudspeaker History
Western Electric 300B History and Listening Tests
300B SE Transformer Listening Tests

**VTV #4 Spring 1996** *$12.95*
6L6 History, Types and Listening Tests
Vintage Bookshelf Speakers 1955-1965
Early FM Broadcasting History
HK Citation I & II Amplifier History and Mods

**VTV #5 Fall 1996** *$12.95*
The Ultimate FM Tuner Shoot Out
Red Bank Guided Missle Tubes for Hi-Fi
The Birth of the Marantz 10B
Choosing Rectifier Tubes for your Guitar Amplifier

**VTV #6 Winter 1997** *$12.95*
Fisher 500 - History, Models and Restoration
A Tribute to Avery Fisher by the Fisher Doctor
6550 and KT88 History, Types and Listening Tests
Loftin-White Amplifier History by Alan Douglas

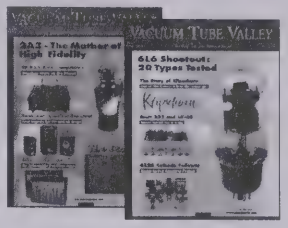
**VTV #7 Summer 1997** *$12.95*
6DJ8 & Frame Grid Tubes + Listening Tests
Altec 1950s Theater Amps and Modifications
The Great Voice - The Peter Jensen Story
Computing with Tubes - The Savage Art
Uncle Eric's Tube Dumpster - 417A/5842

**VTV #8 Fall 1997** *$12.95*
EL84 History, Types & Listening Tests
RCA Tube Mfg at Harrison, New Jersey
200 watt OTL Amp Project by Allan Kimmel
300B Listening Tests: NOS and Vintage Types
Bruce Moore Tube Audio Pioneer

**VTV #9 Spring 1998** *$12.95*
Transmitting Tube Review, Ampeg SVT Guitar
Amp, Altec 287W amp, Bargain Vintage Hi-Fi

**VTV #10 Summer/Fall 1998** *$12.95*
Story of the 6V6, Hi-Fi radio in the 30s,
PP SV572 amp, Ultrapath Line Stage

**VTV #11 Spring 1999** *$12.95*
6SN7: History and Tests, Octal Line Stage
Project, Mid-Priced Vintage High-Fi, OTL
Headphone Amp, Capacitors and FREDs



**VTV #12 Summer 1999** - 2A3 History and Tests, 2A3 SE Amp Reviews, Bookshelf Speaker Test, Scott 299: History and Mods, 300 Watt SV572 Amp Project *$12.95*

**VTV#13 Winter 2000**
6L6 Shootout, Paul Klipsch Interview, Klipschorn Lore and Mods, Scott 222 and LK-48, PP 2A3 Amp Project *$12.95*

**Vintage Hi-Fi Spotter's Guide-Volume 1**
Over 450 photos & specifications of tube audio gear from the Golden Age of Hi-Fi. **86** pp. **$18.95**

**Vintage Hi-Fi Spotter's Guide Volume 2**
Volume 2 covers equipment not listed in Volume 1. Almost 500 amps, preamps, tuners, etc are depicted. Edition covers early audio and includes a Speaker section with most vintage manufacturers. **88** pp. **$18.95**

**Vintage Hi-Fi and Audio Price Guide 2000-2001**
Updated price & grading guide for almost 1,000 vintage hi fi amps, preamps and tuners. Includes Vintage pro audio and theater gear. Also, pro loudspeakers, N.O.S. vacuum tubes and audio transformers. **$20.00**

**"Vintage Hi-Fi The Golden Era Video"**
A one-of-a kind video covering the classic post-war and 1950s home hi fi era. Over 80 classic audio amps, pre-amps tuners, are shown. This video is professionally produced. **34 min VHS NTSC** **$20.00**

**The Ultimate Tube Substitution Guide**
No tube electronics enthusiast should be without this book. Over 10,000 tubes are listed on 240 pages including: audio, radio, transmitting, and special. Features an audio tube section with tube evaluation. **$29.95**

**Vacuum Tube Valley T-Shirts**
***Check our web site for the latest designs! 100% Cotton USA***

**A) 6L6 MUSIC POWER**
Large logo available in black or grey **$18.95 XL only**

**B) VTV Tube Sunburst Logo** with 2-color black & orange on front with large 2-color RCA tube diagram view on back. (Available in gray) **$18.95 L or XL, $21.95 XXL**

**C) VTV Tube Head Cap** - High quality dark navy cap with silver embroidered "Tube Head" on front. "Vacuum Tube Valley" stitched on back. Velcro size adjustment, 100% Cotton **$18.00**

*New and Fresh off the Press!*

**Mullard TUBE POWER EL-34 T-Shirts**
Available in black only with white and luminescent blue art. **$18.95 L or XL**

**Shipping and Handling: US $7.50, Canada $12.50, Europe $22.50, Asia and World $28.50 Each Order.**

**Subscribe To Vacuum Tube Valley**
***The Classic Electronics Journal***

***4 Issues / Year***
$49/year US First Class $40/year US Third Class
$52/Canada $60/Europe
$70/Asia & World

**VACUUM TUBE VALLEY**
P.O. Box 1499
Lakeport, CA 95453 USA
Phone (707) 263-5881 FAX (707) 263-7648
email - triode@vacuumtube.com
**www.vacuumtube.com**

# PRODUCT REVIEW

## *2A3 SOVTEKS*

*Reviewed by Charles Hansen*

*Sovtek 2A3 Power Triode, New Sensor Corp., 20 Cooper Square, Fourth Floor, New York, NY 10003, (212) 529-0466, www.newsensor.com.*

In 1933 RCA introduced the 2A3 direct-heated power triode for audio amplification. The initial design used a single plate and a heater with 20 parallel filaments. Later that decade, RCA redesigned the tube with two short plates in parallel with an inverted "W" filament structure. The performance of the 2A3 has been shown to be sensitive to its filament current.[1]

The RCA manual lists the maximum plate power as 15W. This rating was reported to be conservative for the later two-plate design, with successful single-ended designs of 20W or more.

The Sovtek 2A3s I received for testing are of the single-plate design. These tubes appear to have a robust construction. They were hand-marked with black paint, so I assume they are prototypes of the production versions. I received four tubes, with sample numbers marked on the tops: 12, 29, 31, and 39, which I refer to in the test data. These tests were strictly objective measurements—I did not install them in an amplifier for any subjective testing.

### TEST DATA

At 5.375″, the tubes exactly met the maximum height of the RCA ST16 outline. The maximum diameter of the Sovtek tube was 2.0″, just under the ST16 maximum of 2.063″. The filament currents for all four tubes were within the specified 2.5A maximum at a filament voltage of 2.5V AC 60Hz. The Sovtek 2A3 filaments are completely enclosed. Even in a dark room their glow was not visible.

No test data was supplied with the tubes. I measured the dynamic characteristics using the Audiomatica Sofia vacuum-tube curve tracer, available from Old Colony Sound Lab, (888)-924-9465, www.audioXpress.com). *Figures 1–4* are the plate curves for tubes number 12, 29, 31, and 39, respectively.

The variations in plate current at a

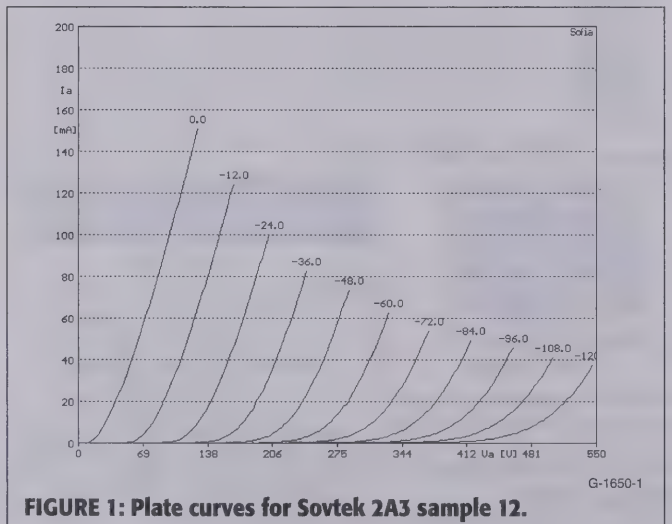



**FIGURE 1: Plate curves for Sovtek 2A3 sample 12.**

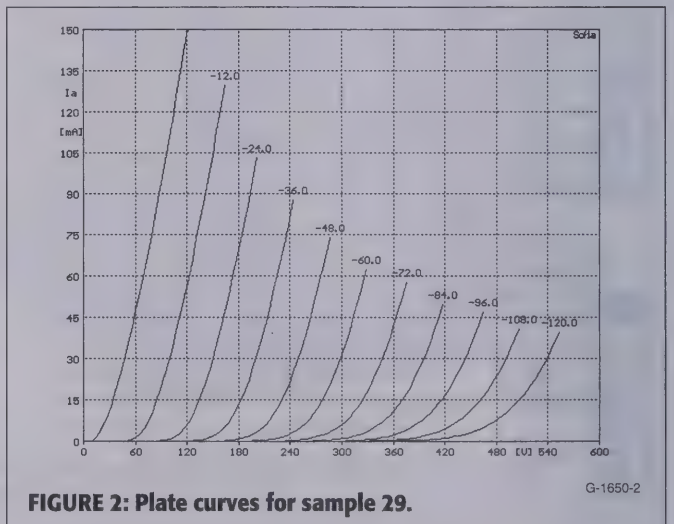



**FIGURE 2: Plate curves for sample 29.**

**SOLEN**

***EUROPEAN*** **SPEAKER DRIVER UNITS CATALOG**

AIRBORNE

LA PASSION DU HAUT-PARLEUR AUDAX

DYNAUDIO®

FEON

LPG

Peerless

scan·speak

seas

vifa

***SOLEN*** **CROSSOVER COMPONENTS CATALOG**

***HEPTA-LITZ*** **INDUCTORS PERFECT LAY HEXAGONAL WINDING**

**STANDARD INDUCTORS PERFECT LAY HEXAGONAL WINDING**

**FAST CAPACITORS METALLIZED POLYPROPYLENE**

**SOLEN CROSSOVER & SPEAKER PARTS**

***SOLEN*** ***INC.***
4470 Ave. Thibault
St-Hubert, QC J3Y 7T9
Canada

Tél.: 450-656-2759
Fax: 450-443-4949
E-mail: solen@solen.ca
www:http://www.solen.ca

**Catalog US$8.00 Refundable**

NEW

# SOLEN

ELECTRONIC

***Fast Capacitors...***

***... pure music enlightenment***

## *Fast capacitors metallized polypropylene*

*51 µF 630VDC, 100 µF 630VDC*
*51 µF 1500VDC, 0.1 µF to 47 µF 630VDC*
*1 µF to 220 µF 400VDC, 1 µF to 330 µF 250VDC*

***SOLEN INC.***
*4470 Ave. Thibault, St-Hubert, QC J3Y 7T9 CANADA*
*Tél.: 450-656-2759 • Fax: 450-443-4949*
*E-mail : solen@solen.ca*
*www : http://www.solen.ca*

*Reader Service #123*

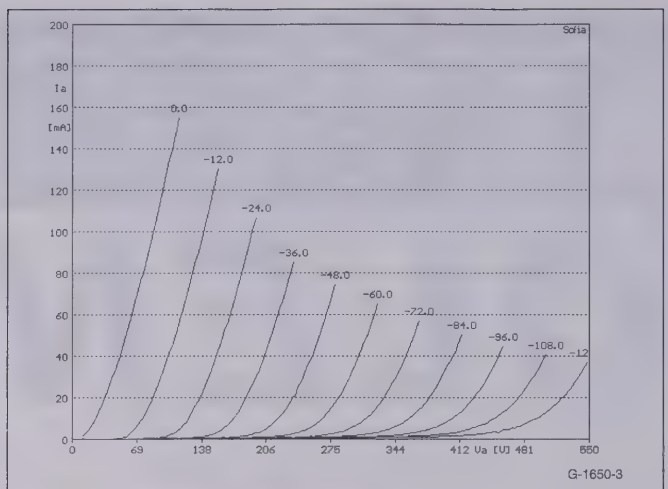



**FIGURE 3: Sample 31 plate curves.**

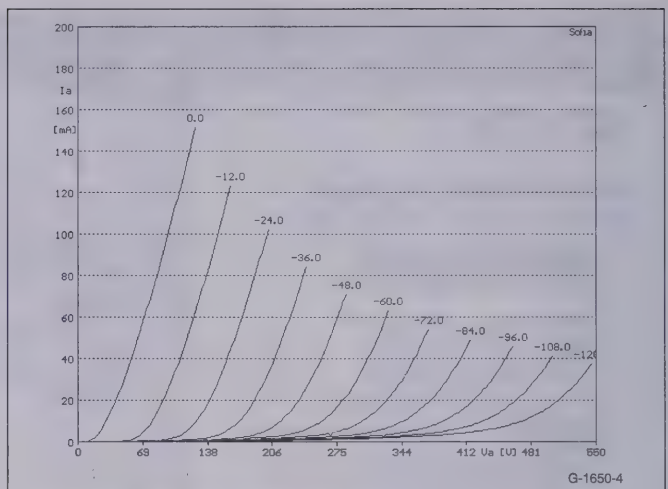



**FIGURE 4: Sample 39 plate curves.**

**TABLE 1**
**COMPARISON OF PLATE CURRENTS AT V**

**K = 250V DC, VG = –48V DC**

| 2A3 SAMPLE | IP (mA RMS) | Gm (mA/V) | μ | Rp (kΩ) | P (watts) |
|---|---|---|---|---|---|
| 12 | 30.0 | 6.17 | 6.75 | 1.06 | 7.50 |
| 29 | 31.0 | 6.87 | 6.82 | 1.00 | 7.76 |
| 31 | 34.6 | 8.05 | 6.99 | 0.90 | 8.65 |
| 39 | 32.4 | 6.05 | 6.90 | 1.08 | 8.11 |

fixed plate voltage of 250V DC and a grid voltage of –48V DC are shown in *Table 1*. I have listed the Gm, μ, Rp, and P at the selected test points for information.

I also ran the Sofia matching program, and numbers 12 and 29 were matched with an ERR of 88. The remaining two tubes matched with an ERR of 237.

ERR is a dimensionless figure of merit representing the smallest root-sum-square differences between the measured values of plate current and plate voltage over the specified range of grid-bias values.[2] The lower the number, the better the match. An ERR of less than 100 is a very good match. ❖

**REFERENCES**

1. "Filament Power and Performance of the 2A3," Don Jenkins, *GA* 5:36, pp. 42–45.
2. "The Sofia," Don Jenkins, *VAT News* 3(2), pp. 11–19.

NHC Tubes Parts Others Brenner's Foreign Trading and Supplying Corp.

NHC Brenner's Corp.
**Miskolc**
Perczel Mor u. 2.
H-3529 HUNGARY
Order : by Fax / E-mail or letter:
Payment: by Credit Card, EuroCard Mastercard, Bankers Draft, or Transfer

http//www.nhcbrenners.hu
**E-mail:** brenners@elender.hu
**Our fax number:**
-36-46-431-742 or -36-30-9807-891

**TUNGSRAM**

| | | |
|---|---|---|
| ECC 81.....10,00 | AZ 1.....9,00 | E 86 C.....8,00 |
| ECC 82.....10,00 | AZ 12.....11,00 | E 180 F.....6,00 |
| ECC83.....25,00 | AZ 21.....5,50 | 6X4.....6,00 |
| 12 AX 7.....25,00 | AZ 4.....7,50 | E80F/EF86.....22,00 |
| ECC 808.....25,00 | AZ 41.....5,50 | E88CC Gp.....30,00 |
| ECC 85.....10,00 | PV 200/600.....8,50 | E182CC.....18,00 |
| E 80 CC.....20,00 | PV 200/1000..16,50 | **VALVO** |
| E 88 CC.....15,00 | EZ 4.....8,50 | E 86 C.....8,00 |
| EF 40.....6,50 | EZ 40.....6,50 | E 180 CC.....10,00 |
| EF 86.....14,00 | EZ 80.....5,50 | EL 90.....6,00 |

**SIEMENS**

ECC 81.....18,0
ECC 88.....16,0
E 283 CC.....20,0
E 288 CC.....16,0
ECF 80.....6,0
E 80 CF.....8,0
E88CC Gp.....28,0

**MINIWATT**

E 182 CC.....18,00
6 AQ 5.....6,00

**RCA**

12AY7.....'63..30,00
12AY7.....'58..40,00

**BRIMAR**

CV4004.....40,00

**PHILIPS**

E 86 C.....8,00
E 180 F.....6,00
6X4.....6,00
E80F/EF86.....22,00
E88CC Gp.....30,00
E182CC.....18,00

**VALVO**

E 86 C.....8,00
E 180 CC.....10,00
EL 90.....6,00

**TELEFUNKEN**

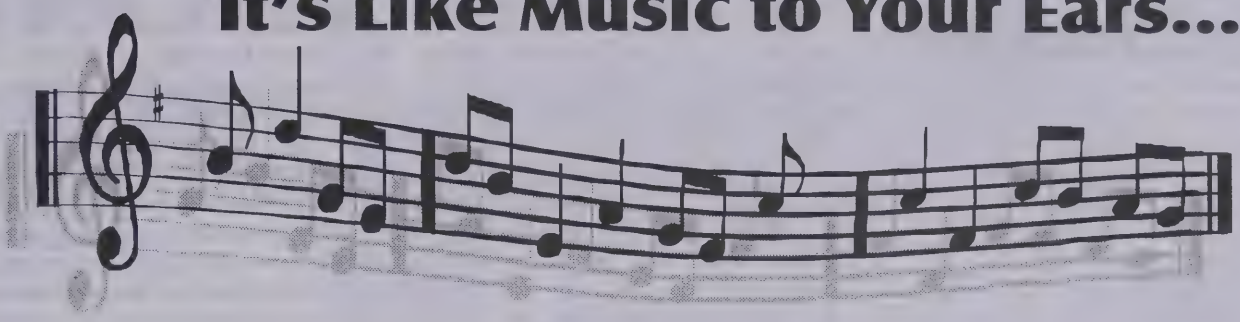
EC 88 Gp.....8,00
ECF 80.....10,00
E 80 CF.....12,00
ECC81..WB....35,00
ECC801S/WB.45,00
ECC802S/WB.45,00
EF 804S...WB.40,00

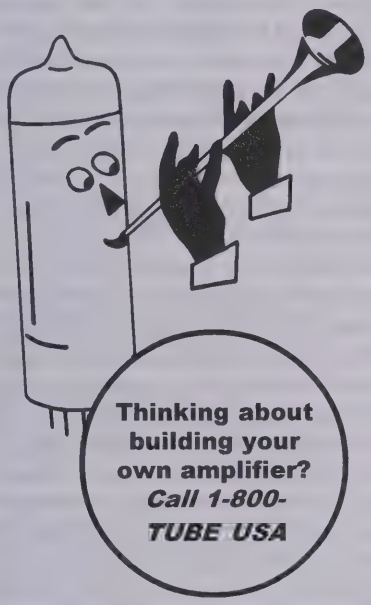
All Tubes princes USD/each

All prince is export + shipping fee + packing. Min. order: 100USD.
Quantity discount available. We shall send proforma invoice if necessary.
Shipping: SEA MAIL, AIR MAIL, EMS, UPS, TNT EXPRESS, AIR FREIGHT

*Reader Service #85*

# It's Like Music to Your Ears...






# Amperex Bugle Boy

## *audio tubes are back and they're better than ever!*

When it comes to selecting premium audio tubes for your amplifier, accept no less than the best, Amperex Bugle Boy! Amperex Bugle Boy tubes are burned in under full load with all voltages applied for 24 hours before being tested for noise & microphonics. The aging racks used are from the original Amperex production line built in Holland decades ago.

Complete test results are supplied with each tube, including plate current, screen current, filament current, and total harmonic distortion (THD). The THD measurement is performed using one of the finest spectrum analyzers available – the Hewlett Packard 3561A. Matching in pairs, quartets & octets is available for all tube types.

Special test requirements? Not a problem. For a slight additional charge we will test and match to your specified operating conditions.

Types available: **6DJ8/ECC88, 12AU7A/ECC82, 12AX7A/ECC83** and many more!

So if you haven't dealt with a source capable of meeting your demands, call us at **1-800-TUBE USA** or **630-208-2200** today for information on additional products and the worldwide locations nearest to you. You'll like what you hear!

**Call *1-800-TUBE USA* or *1-800-882-3872* today for your copy of our APD brochure featuring Audio Tubes, BLUENOTE and Hammond products .**

*APD is pleased to announce the addition of Hammond Manufacturing's entire product line, including Classic Transformers and Enclosures. Call today for a Hammond catalog or down load it from our website at* ***www.rell.com/edg/hammond.html***.

HAMMOND MANUFACTURING™

RELL Online catalog.rell.com Catalog

**Richardson Electronics**
**Engineered Solutions**

**APD Audio Product Division**
**a division of Richardson Electronics, Ltd.**

**40W267 Keslinger Road • P.O. Box 393 • LaFox, IL 60147-0393**
**(630) 208-2200 (800) 882-3872**

**For more information visit our on-line catalog at *catalog.rell.com***

*Reader Service #96*

## 6X4 SPECS

I just received the 3/00 issue of *GA*—full of great ideas and info (as usual).

The soft-start circuit by Michael Kornacker ("Glass Shard," p. 70) is quite impressive, but Mike is wrong about the 6X4's heater current (which he indicated is .3A). The correct rating is .6A. The .3A rating does apply to the 12X4, which is the 12.6V version of this rectifier. Radio Shack has a few 12.6V transformers in stock to heat the 12X4.

**Neal A. Haight**
**Castro Valley, CA**

Michael Kornacker responds:

Thanks for the info, Neal; you are absolutely correct. I looked up the 6X4 in my 1977 edition of the ARRL handbook, which was one of the sources for my information. It stated that the heater current was .3A. I then checked my 1958 edition, which listed it at .6A. Which one was right?

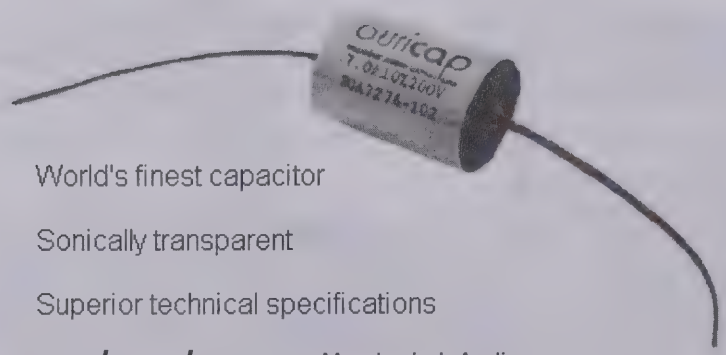
I looked into my box of tubes and found 6X4s all of different manufacture. I applied 6.3V to each and all drew .6A, which settled the matter. For kicks, I found three or four internet sites that had specs for the 6X4. One of them listed the heater current at .3A. So I guess there seems to be some confusion, but .6A is correct.

While I'm here, Paul Becker, who wrote the original article (*GA* 4/94, p. 20), was kind enough to drop me a note telling me that the maximum heater to cathode voltage for the 6X4, which I had stated in my article was 100V, should be 450V. He's correct, too.

Actually, there are two specs for maximum heater-cathode voltage listed in the Sylvania tube manual, where I got my information. The first states, "Heater negative with respect to cathode...450V," and the second, "Heater positive with respect to cathode...100V." The first spec is the one that best applies to our situation.

It might be clearer if the first spec were reworded to read, "Cathode positive with respect to heater...450V." This tells us that if the 6X4 is placed in the power-supply lead as Paul suggested, then as long as the cathode voltage is less than 450V no problems should result. If the 6X4 is placed in the center-tap to ground lead as I suggested, any potential problems will be completely minimized. Either way will work, though. My thanks to Mr. Haight and Mr. Becker for straightening me out on the spec issues.

auricap




World's finest capacitor

Sonically transparent

Superior technical specifications

***used oem by:*** Meadowlark Audio
Electronic Visionary Systems
Air Tight
Coincident Speaker Technology

*Now available by audience for your finest designs!*

**View impressive test results comparing auricap to some of the world's leading audio capacitors at www.audience-av.com or call (800) 565-4390**

*Reader Service #105*

## TUBE TESTIMONIAL

I would like to offer some comments in regard to the use of 866A mercury-vapor tubes mentioned by Mr. Badalamenti ("Letters," *GA* 2/00).

I use the 866A and its "Big Brother," the 872A, in RF induction heating equipment in cathode-ray tube manufacturing. These tubes are rugged, will take a lot of abuse, and have a long life. They will withstand power-line surges (i.e., lightning strikes) without catastrophic failure, which can destroy expensive power transformers.

In response to the letter, Eric Barbour mentioned a good point about reverse-arcing. This can happen if the anode voltage is applied with load before the filaments and mercury vapor in the bulb have reached operating temperature. My RF equipment has time-delay relays in the plate transformer circuit to allow for this—3 minutes minimum for the large units and 90 seconds for the smaller ones. I recommend the three-minute delay time for new equipment design, with choke input filters.

The Altec 287W is an excellent classic amplifier, that provides a good application of the 866A for audio use. The 872A is also good for audio, but is rated higher.

**Joseph K. Risher**
**Sounds Great! Enterprises**
**Stone Mountain, GA**

## TUBE DIFFERENCES

With regard to "A Basic 50W Stereo System" (*GA* 2/00, p. 24), there is a misconception about 5881s. The 5881 is a direct sub for 6L6GB and earlier versions; it is not a sub for the 6L6GC.

Plate dissipation is quite different. The 6L6GB/5881 is 23W, the 6L6GC/7581 is 30W, and the 7581A is 35W. Only the 7581A can replace any of the previous versions. This rating is the same in RCA, Sylvania, and GE OEM data sheets. I haven't seen the data on the Russian 5881 versions, so I can't comment on them.

With regard to the letter entitled "Tube Choices" ("Letters," *GA* 2/00, p. 62), the 6BG6GA tubes with the same internal



*Reader Service #102* →

# The Very Best of British Hi-Fi

## ROKSAN

**THE VERY BEST AMPLIFIER** would be at once heavy and unobtrusive, offering both **raw power** and delightful **finesse.** That describes the Roksan Caspian, available as either integrated or power amplifier.

***HI-FI NEWS & RECORD REVIEW:*** *"You'll never forget that you're getting more than your money's worth."*

***HI-FI WORLD:*** *"It looks like Roksan have produced something rather special."*

***WHAT HI-FI?:*** *"The Caspian's big, warm sound, real-world ability with tricky speakers and attractive styling should see it do very well."*

***ULTRA HIGH FIDELITY MAGAZINE:*** *"Even if this amplifier cost a few hundred dollars more, it would be long on the shopping list of numerous audiophiles looking for musical satisfaction. At its current price, it is an unqualified bargain."*

## CASTLE loudspeakers

**BRITAIN'S VERY BEST SPEAKER** is—and always was—Castle. The fine woodwork says "tradition." The advanced drivers and unique loading configurations say "leading edge technology."

***HI-FI WORLD:*** *"The Harlechs take top honours—they're bold, balanced and utterly enthralling, no matter what your musical poison may be."*

***WHAT HI-FI?:*** *"The new Severns not only sound fabulous but are excellent value."*

***GRAMOPHONE:*** *"The (Severn) 2SEs remained continually impressive. The fullness of their tonality and marked reduction in coloration release cleaner harmonics from the violins and woodwinds. It can also rock'n'roll but, unlike many, does so without compromising the impressive qualities we've already outlined."*

***HI-FI WORLD:*** *"Even hardened Rockers could learn a thing or two about their favourite tracks from these (Castle Pembrokes)."*

**ABOVE:**

A Castle woofer equipped with a knitted cone of carbon fibers—one of several drivers developed by Castle to obtain performance not available from off-the-shelf parts.

**AT LEFT:**

The Castle Harlech, whose twin woofer and unique rear loading method brings reference quality to your system. See it and other Castle loudspeakers at your Castle dealer.

## Visit us on line

for Roksan, Castle, Enigma, Harmonix-Enacom, Target, Gutwire, Van den Hul, BBC cones, Focus Audio speakers!

*Buy audiophile recordings on-line from The Software Store:*

Opus 3, Proprius, FIM, Victor xrcd, Three Blind Mice, Sheffield, Water Lily, Golden String, GML, Turtle Records, Audioquest!

**www.mayaudio.com**

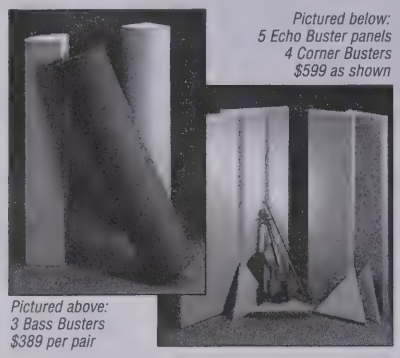
MAY AUDIO MARKETING

2150 Liberty Drive, Unit 7
NIAGARA FALLS, NY 14304-3780
*Tel.:* (800)554-4517 (716)283-4434
*Fax:* (716)283-6264
*E-mail:* info@mayaudio.com

*In Canada:* (905)780-0079

No matter how exotic your audio system may be, its success will depend on your room's ability to allow the re-creation of the original acoustical space.

Echo Busters will help you realize the full potential of your system with our complete line of treatment packages.



*Pictured below:*
*5 Echo Buster panels*
*4 Corner Busters*
*$599 as shown*

*Pictured above:*
*3 Bass Busters*
*$389 per pair*

"I have tried many accessories that I can't imagine being without, but the Echo Busters are more indispensable than any of them." – *Dr. Kelly Tang*

**ECHO BUSTERS**
DECORATIVE ACOUSTICAL TREATMENTS

**Check local dealer or call 1-888-ECHO BUST or 613-643-6895**
2 Vauxhall Ct., Melville, NY 11747 Fax: 613-253-0298
Email: echobusters@worldnet.att.net www.echobusters.com

***Reader Service #67***

parts as the 7581A were a particular "run" of JAN military-grade tubes from the '80s. These 6BG6GAs are indeed the same as the 7581A and will definitely run with 35W plate dissipation and easily take 600V plate. However, these are the only versions that will take this power level. Regular 6BG6GAs are rated at 19W and will fry very quickly.

Visually, the 7581A and 6BG6GA are identical; only the pin-outs and plate cap are different. You can tell whether or not you have the high-powered 6BG6GA by the size of the plate. I have both versions of the 6BG6GA, and there are definite differences between them.

One other note here: the 807 which Eric Barbour mentions ("Letters," *GA* 2/00, p. 67) is also from the 6L6GC family; its plate is rated at 30W and 750V. It is not socket-compatible with the 6L6 family and needs a plate cap; otherwise, it is identical. It is possible to pull up to 80W out of a push-pull Class AB2 807 circuit, but that's the limit, and I doubt you could get 100W out of a pair of them for very long.

I must disagree with Mr. Barbour on the supply of 807s. I haven't had any trouble finding them just about anywhere, and they tend to be lower in cost than 6L6GCs. While no one is making them now, I don't see any shortage developing for quite some time. I do agree with him that the Chinese 807s are not reliable.

**Edwin G. Pettis**
**Pettis Engineering**
**Grand Junction, CO**

Mike Gustafson responds:

Thank you very much for taking the time to point out the plate-dissipation differences between the 6L6GC and the 5881. You are correct: the 5881 does have a lesser plate-dissipation value than the 6L6GC, which has the higher plate dissipation, at 30W, and is a safe substitution for the 5881 at 23W. All other parameters appear to be the same. Since the 5881 is no longer made, the circuit as described will work just fine using the 6L6GC.

In my opinion, plate dissipation is a concern only when thinking in terms of maximum output power for long durations, as in instrumentation amplifiers or guitar amplifiers. The idle current/power is set such that it is below the maximum value for either tube, and it becomes peak power that could exceed, for short durations, the maximum plate dissipation of the 5881. Most "normal" audio applications would never push either tube to a point failure when used in the described circuit.

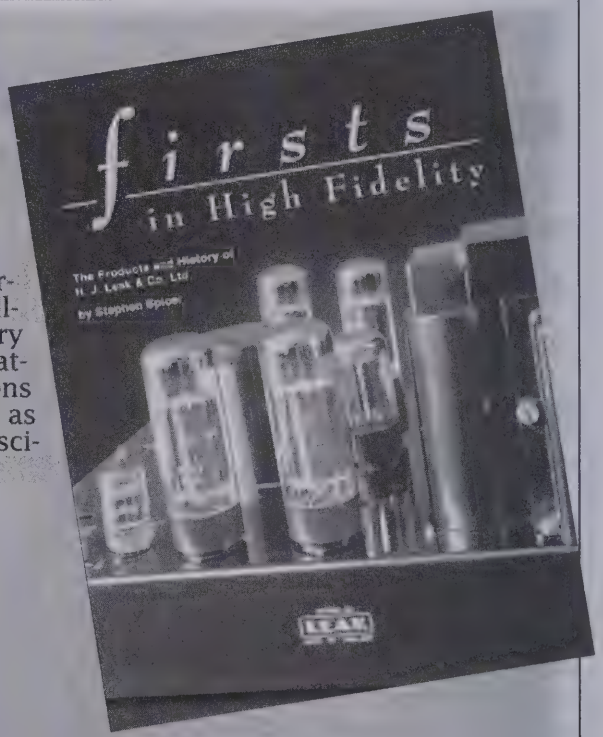
*firsts in High Fidelity*

*The Products and History of H.J. Leak & Co. Ltd.*

by Stephen Spicer

One of the premier high-quality British audio manufacturers of the mid-twentieth century, Leak's products are well-known for their unique and innovative designs. The history of this impressive company is chronicled here with great attention to detail. This book includes over 300 illustrations and 30 circuit diagrams. Vintage audio enthusiasts as well as fans of high-quality reproduction will find this book fascinating. 2000, 272pp., softbound, ISBN 1-882580-31-1.

BKAA58.....$24.95
**Call 1-888-924-9465 to Order**

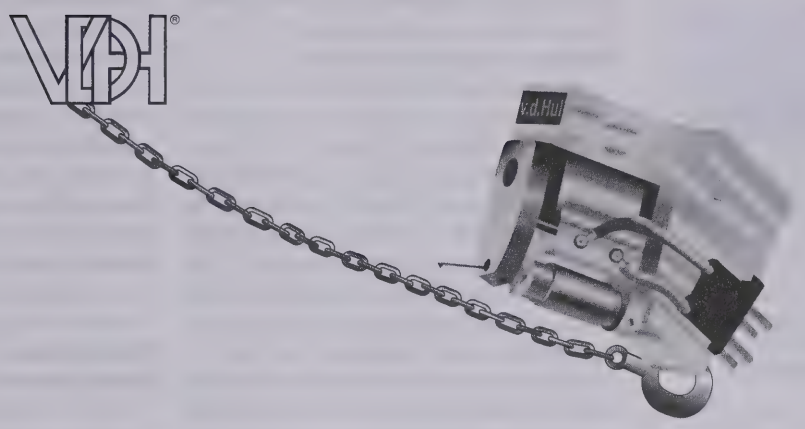



**Visit Us On-Line at *www.audioXpress.com***

**FAX:** (603) 924-9467 • **PHONE:** (603) 924-9464 • **E-MAIL:** custserv@audioXpress.com

OLD COLONY SOUND LAB, 305 UNION STREET, PO BOX 876 DEPT AO, PETERBOROUGH, NH 03458-0876 USA

# What if it bites the dust during my LP marathon?




A thing like that could happen to any moving coil phono cartridge. After all, it's only the engine of the analog system. And all engines wear out. Eventually.

Which is why there is a group of dedicated van den Hul dealers who can arrange to re-tip or re-build yours, ours, nearly any brand of moving coil cartridge (our form of towing service). Just get it to your van den Hul dealer. We'll get it back to you ready to roll.

Why should we blow our horn here? Because van den Hul is still committed to making reference standard phono cartridges (including the legendary Grasshopper).

We've been doing it longer than most and we have attributes you won't find among the Johnnies-come-lately in cartridges.

Like an extremely long stylus life with normal care——up to 3,000 hours (that's about four years at two hours a day, every day).

Like a stylus shape (VDH 1) that maximizes contact with the LP groove to get more music and less noise.

Like low rebuilding cost for any moving coil you want to get cranking again, whether van den Hul or not.

So if you want to find out how healthy van den Hul can be for your LP playback engine, break down and call us. Before, during, or after your next desert island LP marathon.

van den Hul® bv

THE LINK BETWEEN TECHNIQUE AND EMOTION

**Stanalog Audio Imports, Inc.**

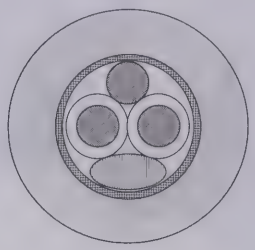
P.O. Box 671, Hagaman, New York 12086 • 518-843-3070

**www.vandenhul.com**

**SILVER SONIC™**
Audio Cables

*Making the High End Affordable!*

"With tube amps and hybrids, the Silver Sonic competed with the best."
*Bound for Sound*



Silver Sonic T-14 Speaker Cable
Silver Sonic BL-1 Series II Interconnect
Silver Sonic D-110 AES/EBU Digital
Silver Sonic D-75 Digital Cable
Hook up wire & Connectors

D.H. Labs, Inc.
612 N. Orange Ave., Suite A-2
Jupiter, FL 33458
(561) 745-6406 (phone/fax)
www.silversonic.com

*Reader Service #73*

## BALANCING ACT

In "A Universal Phase Splitter" (*GA* 1/00), Ari Polisois implies that the outputs of a "concertina" phase splitter will necessarily suffer from an inherent high-frequency imbalance due to the differing anode and cathode output impedances. Morgan Jones commits the same error in his book *Valve Amplifiers*. In fact, the concertina phase splitter will exhibit no such imbalance, provided the modulus of impedance and phase angle of the respective loads on the anode and cathode sections of the splitter are identical.

You can readily verify this by observing that the magnitude and phase angle of the current flowing through the upper load will (subject to the previously mentioned conditions) be the same as that flowing through the lower load. It is only when there is asymmetry between the reactive components of the loads on the respective outputs of the phase-splitter that high-frequency imbalance will occur.

As both the resistive and Miller capacitive components of the loads presented to the anode and cathode of a concertina phase-splitter driver in a conventional push-pull output stage will usually be very similar, no significant high-frequency imbalance will ordinarily be present between the upper and lower outputs.

Furthermore, the topology proposed by Mr. Polisois does not achieve the intended goal of averting high-frequency imbalance between the outputs of his phase splitter. The lower output has a higher effective output impedance than the upper output, and, in conjunction with the substantial parasitic capacitance of the floating power supply on the lower output (only), high-frequency imbalance will occur in typical push-pull amplifier applications.

As with Morgan Jones' suggested solution for the alleged high-frequency imbalance of concertina phase splitters, this is a cure which is worse than the disease! Since Mr. Polisois' circuit has inferior performance to a conventional concertina phase splitter (with greater complexity and cost), it is difficult to see any practical justification for its use in preference to the older topology.

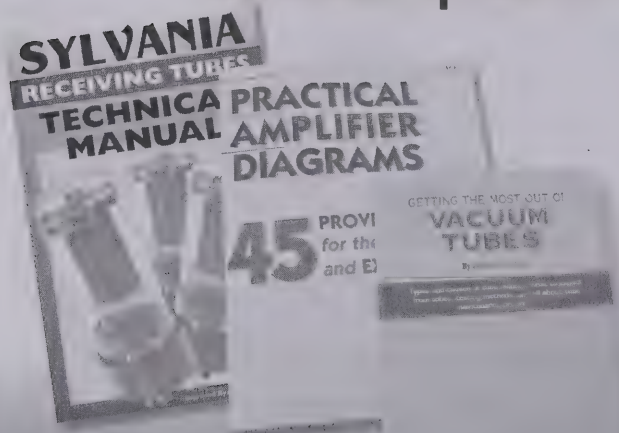
**Clive P. Locke**
**Sydney, Australia**

Ari Polisois responds:

Thank you for your comments on the universal phase splitter.

**3 new tube books**
FROM OLD COLONY SOUND LABORATORY

CALL 1-888-924-9465
TO ORDER OR VISIT US ON-LINE AT
www.audioXpress.com




***Getting the Most Out of VACUUM TUBES*** ➤
**by Robert B. Tomer**
From the cover, "Types and causes of tube failures, what to expect from tubes, testing methods and all about tube maintenance programs." This book is intended to offer explanations of why tubes fail and what to do about it. Discussions of catastrophic and degenerative failures; selecting tubes and tube types and testing and predicting tube performance. 1999, 1960, 160pp., softbound, ISBN 1-882580-29-X. Shipping wt: 2lbs. **BKAA57.....$14.95**

"This is a book for everyone who is really serious about tubes—either designing tube equipment or keeping your music flowing with the least amount of down time and expense. The word classic is often overused, but *Getting the Most Out of Vacuum Tubes* certainly is one."
—Larry Lisle, *Glass Audio*

***Sylvania Technical Manual***
**Sylvania Electric Products Inc.**
13th Edition containing data on more than 3300 electron tubes and semiconductor devices. Reprinted here without the TV picture tube section, this manual contains detailed information on Sylvania's devices including charts and diagrams. A master index is found in the front of the book for easy reference. 1999, 1968, 516pp., softbound, ISBN 1-882580-28-1. Shipping wt: 3 lbs.
**BKAA56.....$19.95**

***Practical Amplifier Diagrams*** ➤
**45 Proven Circuits for the Technician and Experimenter!**
**by Jack Robin & Chester E. Lipman**
A great survey of early amplification. 45 tube circuits ranging from 1 to 75 watts. Many single-ended designs are included. Originally published in 1947, the typewritten original is faithfully reproduced for modern tube audio enthusiasts. 1999, 1947, 98pp., softbound, ISBN 1-882580-25-7. Shipping wt: 1 lb. **BKAA53.....$9.95**

"*Practical Amplifier Diagrams* presents a wealth of proven circuits that can be used as they are or used in part and combined with other circuits. The real value is that they suggest ways of doing things that we wouldn't normally think of."
—Larry Lisle, *Glass Audio*

**Old Colony Sound Laboratory, PO Box 876 Dept LP2, Peterborough, NH 03458-0876 USA Phone 603-924-9464 Fax: 603-924-9467 E-mail: custserv@audioXpress.com**

It is certainly true that both the classic cathodyne topology and mine carry the same potential weaknesses. But, still, the cathodyne remains one of the best and more stable of all phase splitters (at least this is my opinion). Regarding the eventual advantages/disadvantages of my circuit with respect to the traditional one, allow me to call your attention to the fact that it is always possible to have a traditional circuit optimized, as you suggest, but this requires a lot of skill, instruments, and tests, which not everyone can afford.

My circuit, mainly due to the low-value load resistors, as well as their location, appears to be less vulnerable to the negative effects you mention and therefore requires no major adjustment and trimming. Actually, the square waves I get on the oscilloscope are substantially similar in shape up to and beyond 50kHz, on both branches. Parasitic signals rejection is high, even without the additional steps I suggested at the end of page 38 and the beginning of page 40 of my article.

Regarding Morgan Jones' opinions on the concertina, I basically share his points of view. His book is excellent and is a frequently used point of reference for me. Menno van der Veen, the designer of the Plitron toroidol transformers, also shares the same point of view on the classic cathodyne unbalance. You can find this explained in his book *High End Tube Amplifiers From 10 to 100 Watts, Using Toroidal Output Transformers*, Chapter 10.8.

Assembling and testing one unit will allow you to realize that the ARIPS is worth the few dollars more you will spend for its dedicated power supply, which highly enhances its versatility. You will also find out that it does not take more than half an hour to assemble, and that it has very few components, which you can eventually reduce in number, if you suppress the AC-balance network. And, by the way, I do not see how this feature can be applied to the classic concertina.

*[Refer to the following letter, which addresses some other issues on the circuit and its behavior.—Ed.]*

Ari Polisois' article about a universal phase splitter reminds me of a series of articles by our famous "Lucien Chrétien," dedicated to the analysis of the best available phase splitter, published in the '60s in the French magazine *Radio Plans*. The conclusion of these fantastic articles was that the "cathodyne" or "concertina" was probably the simplest and most efficient phase splitter, despite the fact that it has the disadvantage of a unity gain and is the oldest available design.


Electronic Crossovers
Tube
Solid State
Powered
Passive Preamps
46 Step Attenuator
Power Amps
100% MOSFET

XM126 tube xover, available 2,3 and 4 way

*All available as kit also*
*Free Catalog:*
Marchand Electronics Inc.
PO Box 473
Webster, NY 14580
Phone (716) 872 0980
FAX (716) 872 1960
info@marchandelec.com
www.marchandelec.com

Reader Service #52

**Introducing...**

VacuTrace™

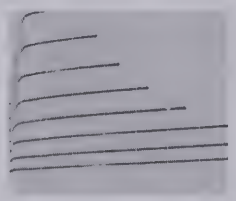
**Vacuum Tube Curve Tracer**

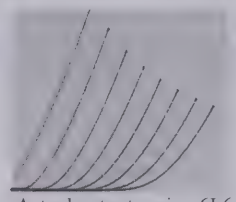
**$999**

- Generates characteristic curves for diodes, triodes and pentodes in real-time
- Tests both small signal and power tubes: 12AX7, 6SN7, 5Y3, KT88 and 300B
- Performs matching – even on dual tubes
- Sweeps to 400V anode, 200mA cathode, -70V grid and 20W power
- All analog design with digital readout of voltages, current, transconductance and transadmittance
- Four socket adapter cards accommodate most popular tubes and pinouts
- Uses oscilloscope (not included) as display

**New!**

Kit version available soon





Actual outputs using 6L6

**For more information or to order, visit www.hagtech.com**

HAGERMAN TECHNOLOGY

MasterCard VISA

Patents pending

Hagerman Technology LLC
PO Box 26437
Honolulu, HI 96825 USA

Fax: 808.394.6076
www.hagtech.com

Nevertheless, the analysis pointed out two main difficulties: The first one is due to the parasitic capacitors that bypass the resistors located in the anode and cathode paths, because they are acting in a way that produces an increasing imbalance between the outputs, with the increasing frequency. The second one is an inherent imbalance between the output impedances. Different solutions were proposed to minimize these unwanted effects. All of them are well known, very efficient, and based on a reduction of the load resistors.

Ari Polisois' universal phase splitter is a cathodyne in which the load resistors are strongly reduced. Consequently, it is not surprising to achieve better performances with this clever and elegant new topology. Nevertheless, I have some questions:

- Reducing load resistors on a standard cathodyne is also possible and will provide the same advantages. So why did you decide to change the topology? Is it because the new situation for the parasitic capacitors is more interesting to justify such a modification?
- The proposed new topology does not allow a high-level output voltage. The result is the need for an extra gain. So, don't you think that you run the risk of losing the quality you get with this new design?

**P.J. Touzelet**
**Velizy, France**

Ari Polisois responds:

As you pointed out in your letter, in my circuit the load resistors are strongly reduced in value and, therefore, definitely minimize the unwanted effects you mentioned.

I appreciate your nice words of evaluation. Please refer to the last two paragraphs of my article (p. 32). The main achievement of the layout is the reduction of the load's value in order to decrease the effects of the stray (static and dynamic, or Miller) capacitance that precede and follow.

The circuit described relates to a phase splitter in its essential function (that is, splitting the signal) and, by its nature, has no extra gain (actually, the gain is close to 0.6 per branch, meaning an output of 0.6 + 0.6V, if the input is 1V).

In the Williamson classic circuit, the cathodyne section is preceded by a direct-coupling amplification to compensate for the gain loss. Using an ECC82/12AU7, I also tried this solution with satisfactory results.

With respect to the classic cathodyne arrangement, the circuit I described also has a few additional merits. First of all, it is quite independent (the connection to any other power supply is definitely remote) and, second, it can eventually be direct-connected to the following stage (i.e., without the use of coupling capacitors—but, of course, the positive potential of the signal coming from the cathode must be compensated). Being self-contained makes it more versatile for different applications. As an additional explanation, in a new amplifier I constructed I needed to use the CD player's output without attenuation (about 0.2V) because the following stages were supplying enough amplification (no overall negative feedback used) to drive the output tubes to the required power.

In such a case, the ARIPS fitted satisfactorily, right at the input (incidentally, it could easily handle up to 2V–10 times).

*Merci*, Mr. Touzelet. I read your articles in *GA* with much interest, and, by the way, at the time I attended the Ecole Centrale de TSF courses, Lucien Chrétien was in charge.

## TRANSFORMER IMPEDANCE

*Figure 1* shows a method that I successfully use to determine the impedance of tube-type output transformers. At first


PRICE VALIDITY TO END APRIL 2000 – Ask About Any Type Not On This List

CHELMER VALVE COMPANY

*for High Quality Audio Tubes*

Everybody in the tube business knows that the justly famous Brand names of yesteryear like BRIMAR. GEC. MULLARD. RCA & TELEFUNFKEN Etc. Etc. are scarce and often very expensive.

Although we supply all major brands when available (and have many in stock) our policy is to offer a range of tubes, mostly of current manufacture, the best we can find from factories around the world, which we process specially to suit audio applications. The result - CVC PREMIUM BRAND.

Our special processing includes selection for LOW NOISE, HUM & MICROPHONY and controlled BURN - IN on all power tubes to improve STABILITY and select out tubes with weaknesses Etc.

A selection of CVC PREMIUM Audio Tubes

| PRE-AMP | | POWER TUBES | | POWER TUBES | | SOCKETS ETC. | |
|---|---|---|---|---|---|---|---|
| ECC81 | 5.20 | EL34G | 7.70 | 6146B | 10.50 | B9A (Chassis or PCB) | 1.60 |
| ECC82 | 5.20 | EL34 (TESLA) | 8.20 | 6336A | 46.00 | B9A (Ch. or PCB) Gold Plated | 3.00 |
| ECC83 | 5.20 | EL34/6CA7 (Large Dia.) | 10.70 | 6550A | 11.00 | Octal (Ch. or PCB) | 1.80 |
| ECC85 | 6.00 | EL84/6BQ5 | 4.80 | 6550WA or WB | 13.50 | Octal (Ch. or PCB) Gold Plated | 4.20 |
| ECC88 | 5.00 | EL509/519 | 13.00 | 7581A | 11.00 | 4 Pin (For 2A3, 300B Etc.) | 3.30 |
| ECF82 | 5.00 | E84L/7189A | 6.50 | 807 | 9.00 | 4 Pin (For 2A3,300BEtc.)G/Plated | 5.00 |
| ECL82 | 5.20 | KT66 | 9.50 | 811A | 11.00 | 4 Pin Jumbo (For211 Etc.) | 11.00 |
| ECL86 | 5.20 | KT66R | 22.00 | 812A | 34.00 | 4 Pin Jumbo (For211 Etc.) Gold Plated | 15.00 |
| EF85 | 5.60 | KT77 | 12.00 | 845 | 30.00 | 5 Pin (For 807) | 3.00 |
| E8OF Gold Pin | 10.00 | KT88 (Standard) | 12.50 | RECTIFIER TUBES | | 7 Pin (For6C33C-B) | 4.50 |
| E81CC Gold Pin | 6.80 | KT88 (Gold Special) | 21.00 | EZ80 | 4.20 | 9 Pin (For EL, PL509, Ch. or PCB) | 5.00 |
| E82CC Gold Pin | 8.00 | KT88 (GL Type) | 30.00 | EZ81 | 4.70 | Screening Can (For ECC83 Etc.) | 2.00 |
| E83CC Gold Pin | 7.50 | PL509/519 | 9.00 | GZ32 | 12.00 | Anode Connector (For 807 Etc.) | 1.50 |
| E88CC Gold Pin | 8.00 | 2A3 (4 or 8 Pin) | 14.50 | GZ33 | 10.00 | Anode Connector (For EL 509 Etc.) | 1.70 |
| 6EU7 | 6.00 | 211 | 22.00 | GZ34 | 6.70 | Retainer (For 6LWGC Etc.) | 2.00 |
| 6SL7GT | 8.50 | 300B | 50.00 | GZ37 | 8.70 | | |
| 6SN7GT | 4.60 | 6C33C-B | 27.00 | 5U4G | 5.50 | | |
| 6922 | 5.50 | 6L6GC | 6.50 | 5V4GT | 4.70 | | |
| 7025 | 6.50 | 6L6WGC/5881 | 8.00 | 5Y3GT | 4.20 | | |
| | | 6V6GT | 5.00 | 5Z4GT | 4.70 | | |
| | | 6080 | 11.50 | | | | |

...and a few "Other Brands" (inc. Scarce types).

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5R4GY FIVRE | 7.00 | 6B4G/SYLVANIA | 27.00 | 6SN7GT BRIMAR | 10.00 | 13E1 STC | 110.00 |
| 5R4WGY CHATHAM USA | 10.00 | 6BW6 BRIMAR | 5.00 | 12AT7WA MULLARD | 5.00 | 805 CETRON | 50.00 |
| 5U4GB RCA or GE | 12.00 | 6BX7 GT GE | 8.50 | 12AY7 GE – SYLVANIA | 7.75 | 5842A GEC | 15.00 |
| 5Y3WGT SYLVANIA | 5.00 | 6CG7/6FQ7 SYLVANIA | 7.50 | 12AZ7 GE | 7.50 | 6080W TUNGSOL | 12.50 |
| 6AS7G RCA or SIEMENS | 12.00 | 6CL6 RCA or GE | 5.00 | 12BH7A GE or RCA | 13.00 | 6550A GE | 23.00 |
| 6AU6WC SYLVANIA | 3.50 | 6CW4 RCA | 11.00 | 12BY7A GE | 9.00 | 6146B GE | 17.00 |
| | | 6SL7GT STC | 8.50 | 12E1 STC | 12.50 | ALL PRICES IN U.K. POUNDS £ | |

Please note carriage extra + VAT (EEC only)— When ordering state if matching required (add £1.00 per tube).
Payment by CREDIT CARD (ACCESS, VISA, MASTERCARD) or BANKERS DRAFT, TRANSFER or CHEQUE (UK ONLY).
FAX or POST your ORDER — We shall send PROFORMA INVOICE if necessary

*Valve Amplifiers sound better still fitted with CVC PREMIUM Valves!*
Chelmer Valve Company Ltd. • The Stables • Baddow Park, Great Baddow
Chelmsford, Essex CM2 7SY, England
☎ 44 (0) 1245 241300 • Fax: 44 (0) 1245 241309
E-mail: sales@chelmervalve.com • Web Site: http://www.chelmervalve.com

Reader Service #40

glance, it would appear to be brutal to apply 120V AC to the primary of an audio output transformer. However, the truth is that due to the vast number of turns of wire, typically 2000 or more, and also due to the lack of a secondary load, the power draw is minimal at best.

This procedure allows you to determine the primary-to-secondary winding ratio, which is obtained by dividing the 120V AC primary voltage by the measured secondary (voice-coil winding) voltage. For example, say you measure 4.8V AC. Then, 120Vpri ÷ 4.8Vsec = 25-to-1. Then take the number, 25, and square it ($25^2$) to get 625. Then multiply 625 by the impedance of the speaker, or speaker system you wish to connect to the voice-coil winding after the transformer is installed in an amplifier—say 8Ω—to get 5000Ω. A 16Ω speaker will increase the impedance to 10kΩ, and a 4Ω speaker will decrease the impedance to 2500Ω.

For a center-tapped primary, the 120V AC will be applied at the blue and brown plate leads. This will also be the case of UL transformers.

If a transformer has more than two voice-coil leads, the measured voltage will vary, using the black lead as a common. The lead providing the highest voltage reading will be that of the full output. The lead (or leads) providing lesser voltage (or voltages) will be the tap (or taps).

The 25W bulb will save you a trip to the circuit-breaker panel or fuse box if the transformer is shorted out. It is important to make sure that the voice-coil leads don't touch. Before using this procedure, make sure you have a good transformer by measuring the transformer's primary with an ohmmeter. A

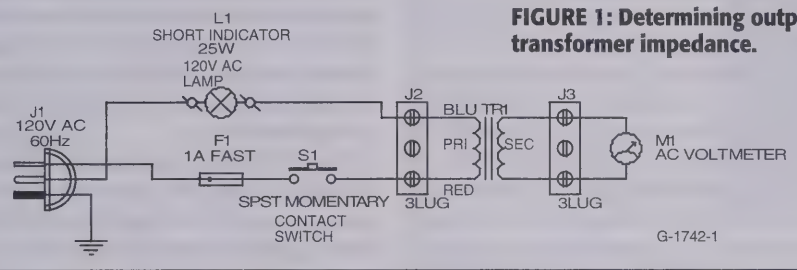



**FIGURE 1: Determining output transformer impedance.**


Watford Valves

The UK's leading specialist in digitally matched and graded valves for the audio industry

**SEE OUR NEW WEB SITE**
**www.watfordvalves.com**

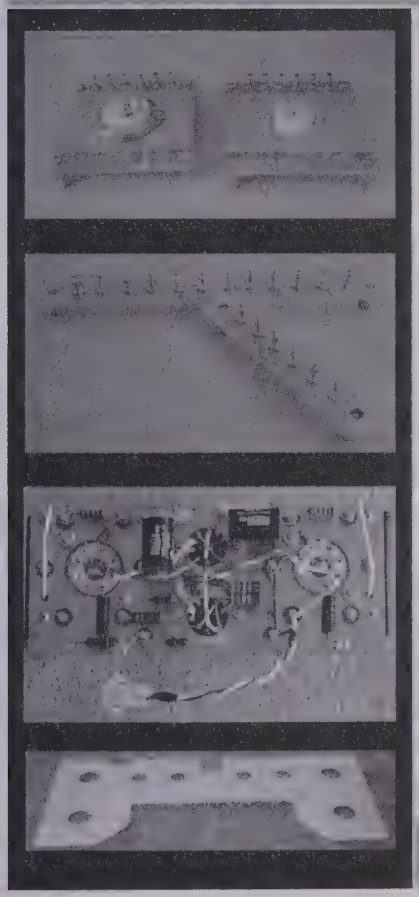
With detailed information and photos of our uniquely advanced custom built test rigs

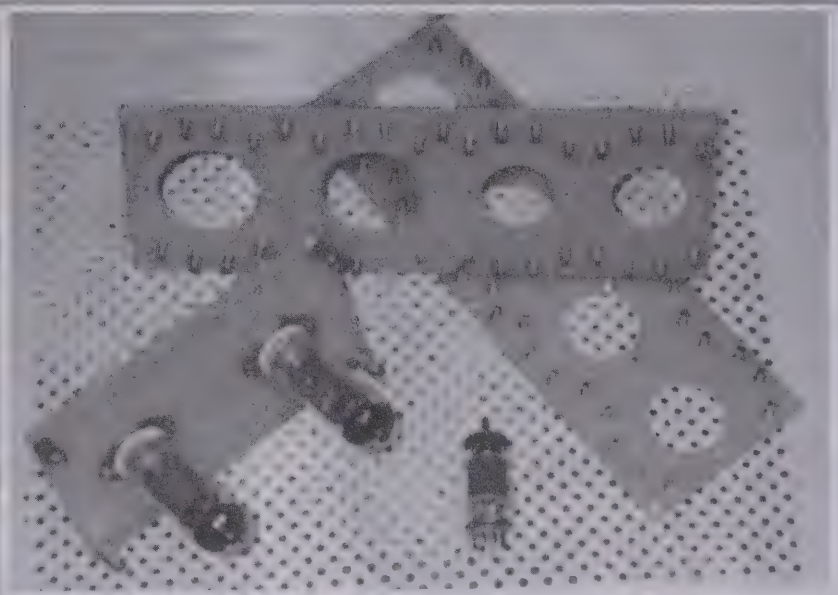
Extensive stocks of N.O.S tubes by Mullard, Siemens, Tungstram, RFT, GEC, Philips etc and current production items by Svetlana, Sovtek & Tesla

**Tel: 44 (0) 1923 893270**
**Fax: 44 (0) 1923 679207**
**www.watfordvalves.com**

*Reader Service #45*

**TERMINAL BOARDS FOR POINT TO POINT**





High quality terminal boards and strips are now available for your projects. Standard and custom sizes available. These rigid, high quality FR4 epoxy laminate .125" thick with copper ground plane, makes project building a breeze. Simply wire the board off chassis then install for a neat looking finish. If you build a lot of point to point projects you need these boards. These boards can be ordered in any configuration, just furnish a digram of the layout and what type of sockets and we can build it. Please call for more details.

INTERNATIONAL AUDIO GROUP
PO BOX 10096
KILLEEN, TX 76547-0096
TEL/FAX +254 699 8702 EMAIL hiag@deshlink.com

*Reader Service #87*

good transformer will read 200Ω or higher. When measuring, make sure voice-coil leads aren't touching.

Lastly, this procedure points out that speaker impedance will always dictate primary impedance. The manufacturer's impedance applies only when specified load is connected to voice-coil leads.

**Neal Haight**
**Castro Valley, CA**

## OTL AMPS

Before much was written about OTL amps, I was interested in the possibility of using a hybrid bi- or triamp with tubes as well as MOSFETs...and also incorporating the inverted amp theory, which reduces the impedance to a lower level and lower voltage for the output power tubes. I will probably need to build my own tube to have a beefed-up grid serve as the output element. I have worked in electronics on just about every kind of equipment built since the 1950s and believe that not all the vacuum-tube discoveries have yet been made. I pulled some old transformers out of 1950s Dukane early transistor amps used in a language lab. Several times through the years I have experimented with tube amps and solid state running in parallel.

I rewired an old Wurlitzer jukebox amp and put in higher-grade hi-fi components to improve the frequency response and distortion levels. I put this tube amp in parallel with a Reference solid-state Studio amp using Studio Tannoys and JBLs. I was surprised, to say the least, at the result: bass through the Reference amp and mids and highs through the tube amp—a very good sounding combination.

Now I wish to try my OTL I have built from scratch (from a *GA* schematic)—using old radar and microwave equipment—with a newer breed of solid-state. I am a firm believer that in the not-too-distant future, the combination of vacuum and solid state will emerge. Audiophiles will take the best of both and savor the result.

In Nashville, I work on many of the vintage amps for musicians. I conclude that the tube has a magical and mystical quality that is hard to measure in quantitative terms, but must be subjectively determined in listening tests. Most musicians that I have dealings with prefer the smooth tube sound. However, some have listened to the combination of hybrid setups and can't detect whether I have a solid-state amp in parallel.

I would be interested in hearing from readers who have tried the combined listening tests on other types of equipment. ❖

**M. J. Humphries**
**Nashville, TN**

## Paralleling Tubes

*from page 16*

cause of this, the use of common self-bias or common fixed-bias is preferred for parallel circuits.

We also wished to know the effects on the harmonic structure that paralleled operation might cause. During the 6SN7 measurement phase, no harmonics above the seventh were measured because they were in or below the noise. Working from one of the previously used equations in Terman's book, we calculated the first seven derivatives, then applied them to the Taylor series to produce plate current equations for the first seven harmonics.

From the harmonic equations in *Table 5*, you can see that adding the plate current curves of two parallel triodes causes the simple addition of their currents of


# LANGREX SUPPLIES LTD

DISTRIBUTORS OF ELECTRONIC VALVES, TUBES & SEMICONDUCTORS AND I.C.S.
1 MAYO ROAD, CROYDON, SURREY, ENGLAND CR0 2QP
24 HOUR EXPRESS MAIL ORDER SERVICE ON STOCK ITEMS
PHONE 0208-684-1166 E-MAIL: LANGREX@AOL.COM FAX 0208-684-3056

**A SELECTION OF OUR STOCKS OF NEW ORIGINAL VALVES/TUBES MANY OTHER BRANDS AVAILABLE**

**STANDARD TYPES**

| | | |
|---|---|---|
| ECC81 | RFT | 3.00 |
| ECC82 | RFT | 5.00 |
| ECC83 | RFT | 6.00 |
| ECC83 | EI | 3.00 |
| ECC88 | BRIMAR | 4.50 |
| ECC88 | MULLARD | 7.50 |
| ECH81 | MULLARD | 3.00 |
| ECL82 | MULLARD | 5.00 |
| ECL86 | SIEMENS | 7.50 |
| EF86 | USSR | 5.00 |
| EF86 | MULLARD | 15.00 |
| EL34 | EI | 5.00 |
| EL34G | SOVTEK | 5.00 |
| E34L | TESLA | 8.00 |
| EL36 | MULLARD | 5.00 |
| EL84 | USSR | 2.25 |
| EL519 | EI | 7.50 |
| EZ80 | MULLARD | 5.00 |
| EZ81 | MULLARD | 7.50 |
| GZ33/37 | MULLARD | 15.00 |
| KT66 | SPECIAL | 20.00 |
| KT88 | SPECIAL | 20.00 |

**AMERICAN TYPES**

| | | |
|---|---|---|
| 5R4GY | RCA | 7.50 |
| 5U4GB | SYLVANIA | 10.00 |
| 5Y3WGT | SYLVANIA | 3.50 |
| 6BX7GT | GE | 7.50 |
| 6FQ7 | SYLVANIA | 7.50 |
| 6L6GC | G.E. | 17.50 |
| 6L6WGB | SYLVANIA | 10.00 |
| 6SL7GT | USA | 5.00 |
| 6SN7GT | USA | 7.50 |
| 6SN7GTB | G.E. | 6.00 |
| 6V6GT | BRIMAR | 6.00 |
| 12AX7WA | SYLVANIA | 6.00 |
| 12BY7A | G.E. | 7.00 |
| 807 | HYTRON | 7.50 |
| 5687WB | ECG | 6.00 |
| 6072A | G.E. | 6.00 |
| 6080 | RCA | 10.00 |
| 6146B | G.E. | 15.00 |
| 6550A | JAN G.E. | 25.00 |
| 7027A | G.E. | 25.00 |
| 7581A | SYLVANIA | 15.00 |
| 6973 | RCA | 15.00 |

**SPECIAL QUALITY TYPES**

| | | |
|---|---|---|
| A2900/CV6091 | G.E.C. | 17.50 |
| E88CC/CV2492 | BRIMAR | 8.50 |
| E88CC/CV2492 | MULLARD | 10.00 |
| E88CC01/CV2493 | MULLARD | 15.00 |
| ECC81/CV4024 | MULLARD | 6.00 |
| ECC81/M8162 | MULLARD | 7.50 |
| ECC81/6201 G. PIN | MULLARD | 8.50 |
| ECC82/CV4003 | MULLARD | 7.50 |
| ECC82/M8136 | MULLARD | 10.00 |
| ECC83/CV4004 | MULLARD | 20.00 |

**SOCKETS**

| | | |
|---|---|---|
| B7G | CHASSIS | 0.60 |
| B9A | CHASSIS | 1.00 |
| OCTAL | CHASSIS | 1.00 |
| OCTAL | MAZDA | 2.00 |
| LOCTAL | B8G CHASSIS | 2.50 |

**SCREENING CANS**

| | |
|---|---|
| ALL SIZES | 1.00 |

**MANY OTHER BRANDS AVAILABLE**

These are a selection from our stock of over 6,000 types. Please call or FAX for an immediate quotation on any types not listed. We are one of the largest distributors of valves in the UK. Same day dispatch. Visa/Mastercard acceptable. Air Post/ Packing (Please Enquire). Obsolete types are our specialty.

*Reader Service #33*

each of the fundamental and harmonics. In no case does any given harmonic cancel with the same harmonic of the other tube; they merely come to an average value. The implication is that the harmonic mix doesn't change except for tubes that are not well behaved, or are very poorly matched.

Using even larger drive levels—that draw grid current or go near cutoff—may very well have different results. No testing was done to simulate parallel operation of very low-level stages, differing bias, push-pull, or non-triode tubes. These studies are left up to you to investigate.

## CONCLUSION

It appears that careful matching of tubes and good circuit design allows good performance from paralleled tubes. Just like most other things in life, there is no free lunch. The capacitive loading that the previous stage must drive increases proportionately to the number of tubes. Also, don't forget to scale all the power-supply components' current capability accordingly.

Most triodes can actually be thought of as two or more sections in parallel. Typically, the major electric fields move in two or more directions. For example,


Moth Audio Corporation

1746 Ivar Ave. Hollywood CA, 90028 Fax 323 464-9100 Hollywood 7-4300

*Moth Audio Announces the si 2A3 Amplifier*

**Moth Audio introduces its new integrated amplifier, featuring classic sound at an affordable price.**

Model **Si2A3** has Moth Audio's elegant design and superb audio engineering. The amplifier produces the same great sound as Moth's popular S2A3. It was specifically developed to offer a home system of high-end standards at an affordable price.

**Si2A3** features:

- Front panel headphone jack
- Alps volume control
- Silver, three input selector switch
- Cardas copper speaker terminal
- Hand Wired
- No feed back
- No coupling caps

**$1695.00**
(without output tubes)

For more information, please contact Moth Audio at the above address or visit: www.mothaudio.com

Big Sound!
Reference 3A Loudspeakers

Directly coupled, hand built, wide range carbon fiber driver is fast, efficient and needs no crossover.

With just a cap on a perfectly matched silk dome tweeter, the music remains intact.

Ideal match for SET amplifiers

www.reference3a.com
342 Frederick St., Kitchener Ontario, N2H 2N9 Canada
Phone: 519.749.1565 Fax: 519.749.2863

Reader Service #108

EUROKIT™

Turntables, tonearms, cartridges are our business!

**High End Turntable Kits from $ 790**

Just need parts?

**We offer**

**platters, bearings, motors, pods, pulleys (78!), plinths, belts etc. Also tonearms, cartridges and a host of accessories!**

Newsflash!

**TWR kit: end the hassle with tonearm wire lugs. The finest tension loaded lugs available. A must for all tonearms!**

**Restore your old turntable,**

**don't throw it on the junk heap.**
**Call us and find out how it's done!**

Get involved!

**AUDIO ADVANCEMENTS LLC**

PO Box 2090 • Branchville NJ 07826 USA • 973 875 8705 • Fax 973 875 8735
Email audadv@earthlink.net
*www.audioadvancements.com*

current travels from the filament past one side of the grid to its adjacent side of the plate. The rest of the current travels past the other side of the grid to its corresponding plate section.

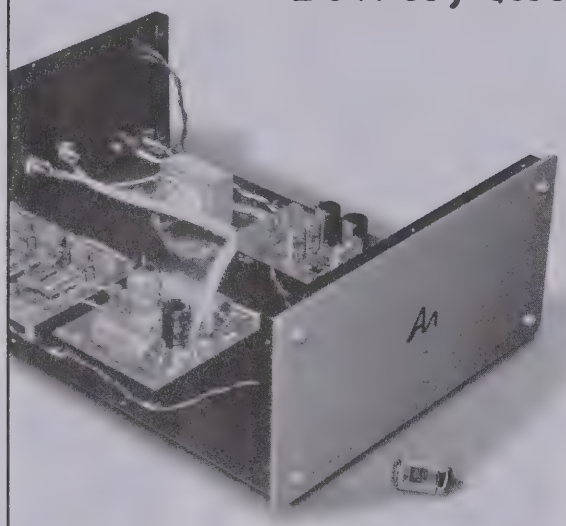
If the tube is designed to be symmetrical and is manufactured with great care, then all "parallel sections" have exactly the same characteristics. Any deviation from this can cause differing values of mu, rp, and transconductance between "sections."

Why further complicate your circuitry by paralleling? There are a few noteworthy advantages: Output impedance is divided and power output is multiplied by the number of tubes that are paralleled. Lower output impedance permits the use of transformers with lower primary impedance. It also allows driving more difficult loads in the next stage for non-transformer-coupled circuits. In both cases wider bandwidth can be realizable.

While you'd think that parallel configuration might significantly increase higher-order harmonics, the measured data, listening tests, and the math did not show it. Sometimes experiments don't always go the way you think they will!

These results may be helpful in the de-

Power, corruption and supplies.



The new Audio Note DAC Kit 1.1.

At $699 US, this tubed output stage one-time oversampling DAC is truly an exceptional value. It's been well received and reviewed... but Mike (being Mike) felt there was some room for improvement, so...

The DAC is out of the bag.

It all happened quite innocently. Mention of a possible power supply upgrade to the popular DAC Kit 1.1 spread like wildfire in the newsgroups.

Mike's only option was to get to work.

The upgrades will include a new power transformer, new PCB, tube rectification, upgraded filtercaps and a gas regulator tube option - WOW!

Projected release Oct 1, 2000.

But what will you do until then?! **Present owners and new purchasers of the DAC Kit 1.1 will receive a substantial discount on the new power supply upgrade kit.**

Don't hesitate - order your DAC Kit 1.1 today and be first in line for the power supply upgrade.

Audio Note North America

1030 Kamato Road, Unit 19, Mississauga, Ontario, Canada · L4W 4B6
Voice: 1.888.523.3359 905.624.6354 Facsimile: 905.624.1868
E-mail: audionote@idirect.com Web: www.audionote.on.ca

Call Mike at 1.888.523.3359 or visit our website for more information. Mike makes your audio day.

*Reader Service #1*

sign of any triode amplifier stage and provide some directions in using paralleled triodes to your advantage. This powerful tool can open possibilities of new ways to get more power, increased bandwidth, and lower impedance stages. You just use multiples of your familiar and favorite tubes. Unless somebody happens to come out with a new, reasonably priced 30–40W output tube, it looks as though our future amp designs will incorporate parallel drivers, outputs, or both! ❖

## SL-60 Loudspeaker

*from page 37*

The last IM test examines cross-intermodulation distortion between the woofer and tweeter using frequencies of 900Hz and 10kHz. (A 1kHz signal would produce intermods that fall on harmonic-distortion lines, confusing the results.) Ideally, the crossover should prevent high-frequency energy from entering the woofer and low-frequency energy from entering the tweeter.

The spectrum resulting from this test is shown in *Fig. 15*. IM products, which are at 6.4 and 8.2kHz, are produced in the tweeter. Total cross-IM distortion is 0.37%, which compares favorably with results from other small monitor speakers.

### AGAINST THE WALL

All of the response data shown so far is quasi-anechoic; that is, the plotted responses are essentially reflection free. According to Kirksaeter, the SL-60 is designed to be placed against a wall. So I placed the SL-60 against a large wall and took additional data (*Fig. 16*).

Two response plots are shown: The solid curve is the response obtained with the SL-60 placed against a wall. The dotted curve is the full-range, reflection-free response with the normal tweeter connection. There is some bass extension due to wall support, but only at the price of a broad 5dB dip in the mid-bass. Furthermore, response above 500Hz is largely unchanged. The dip at 3kHz is not filled in and you still see excessive treble energy in the response.

### CLOSING COMMENTS

Normally I do not make editorial comments in my test reports. I let the data speak for themselves. For this report, however, I am breaking my tradition. According to Dennis Colin, Kirksaeter's American rep maintains that the response dip in the crossover region and the rise in high-frequency response are deliberate. And that when placed against a wall the sound is balanced.

*Figure 16* shows that there is no significant response difference. This is also the reviewer's conclusion. All my experience, coupled with the monumental research done by Dr. Floyd Toole while he was at NRC, Canada, indicates that frequency response is the single most important indicator of loudspeaker quality. The best loudspeakers tend to have the flattest response. It would be a simple matter to correct the SL-60's crossover aberration and eliminate the high-frequency rise. It is hard to believe the result would not be audibly superior to the present SL-60 realization.

Manufacturer's Response:

The Kirksaeter Silverline 60 is a new mini-monitor from designer Per Kirksaeter that uses a unique method of coupling driver and cabinet to the rear wall and floor of the listening room. It achieves bass response below 50Hz, detailed midrange, and a huge sound picture when mated properly with the correct amp and placed correctly in the room. In fact, at both Hi-Fi '99 in Chicago and T.H.E. Show 2000 in Las Vegas, visitors to the Kirksaeter room were amazed at the sound. Female vocalist Diana Krall's "All for you" (IMPD-182) and male vocalist Nat King Cole's Greatest Hits (GZS-1127) seemed to jump out of the small 12-liter box.

The room was a typical hotel room with no fancy, expensive room treatments. The SL 60s were as close to the rear wall as possible and slightly towed in. They were powered by mod-


## AUDIOPHILE / PRO AUDIO COMPONENTS

### CT1 and CT2 Audio Attenuators / Volume Controls

Many are not aware how large improvements in sound quality and in reliability that are possible by replacing a normal audio potentiometer (any make and any price) by one of our stepped Audio Attenuators. CT1 and CT2 offer more effortless sound, more details, better dynamics, lower distortion and larger bandwidth. At the same time they offer better tracking between channels, better attenuation accuracy and better reliability (lifetime >25,000 rotation cycles). CT1 obtained a fabulous full-page review in the British Hi-Fi World magazine. Some of the comments from the review were: '*One ability of this attenuator that's very obvious is its truly crystal clarity*' and '*The CT1's 'invisibility' was its finest asset*' etc.

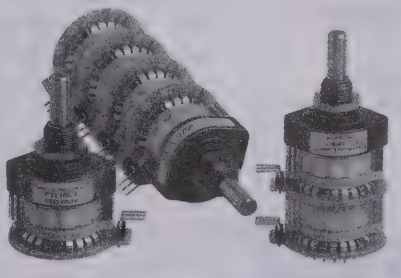
Our stepped attenuators are built on Swiss precision mechanics. They have 24 steps and uses low noise, low inductance SMD metal film resistors. Due to the compact design and the use of SMD resistors, CT1 and CT2 have several times shorter signal path than a conventional stepped attenuator using leaded resistors.

All CT1 and CT2 contacts and conductors are gold plated. Examples of specifications are: Bandwidth 50MHz, attenuation accuracy ±0.05dB, tracking between channels ±0.05dB, THD <0.0001%.

CT1 and CT2 audio attenuators are good choices for volume controls in audiophile preamplifiers, in professional audio equipment and for audiophiles who which to upgrade their existing amplifiers that use less ideal volume controls.

Besides the CT1 and CT2 audio attenuators we are also offering the CT3 audio input selector switch, which is of the same built quality as CT1 and CT2. CT3 switches between up to 5 signal sources.

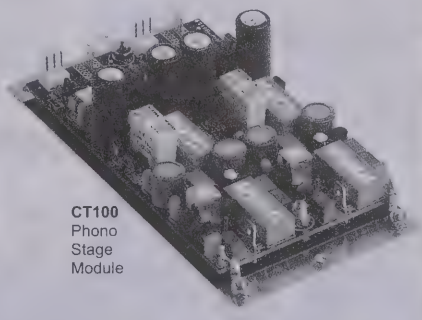
**Photo:** CT1 Audio Attenuators in mono, stereo and balanced stereo versions. Available in 10, 20, 50, 100 and 250 kOhm.



### CT100 Stereo Phono Stage Module

Are you still into vinyl? If yes, our CT100 Phono Stage Module will be interesting for you. CT100 outperforms nearly any known built-in or separate Phono Stage.

The ultimate way of using CT100 is to build it into the cabinet of your turntable. In this way the wires carrying the vulnerable low-voltage signal from the cartridge are shortest possible. Alternatively, you may build CT100 into your amplifier enclosure or a separate enclosure. CT100 has selectable input resistance and input capacitance and various gain settings. By selecting the appropriate settings, CT100 will fit nearly any MM or MC cartridge without requiring separate step-up transformer. CT100 offers unique sound quality and specifications that are hard to find elsewhere: RIAA equalization accuracy ±0.05dB, S/N 98dB at 40dB gain, channel sep. 120dB, THD 0.0003%, output impedance 0.1 Ω. The module containing 2 channels is only 63mm by 105mm and may be operated in dual mono mode using two power supplies. Balanced and non-balanced outputs are built-in.



**CT100** Phono Stage Module

*Made in Denmark*

DANISH AUDIO CONNECT LTD., Rm. 1501/3 Ban Chang Glas Haus Bldg., 1 Sukhumvit Road Soi 25, Bangkok 10110, Thailand
Tel. (+66) 2 260 6070, Fax (+66) 2 260 6071, E-mail: vifadact@loxinfo.co.th, www.DACT.com

DANISH AUDIO CONNECT
DACT
**High quality audio parts and services**

DISTRIBUTORS

TAIWAN
Tang Hill International Ltd.
Tel.: (02) 581 3805
Fax: (02) 564 2918
E-mail: thlinfo@ms4.hinet.net

MALAYSIA
Hi Fidelity Enterprise
Tel.: (03) 987 0128
Fax: (03) 987 0129

UNITED KINGDOM
AudioCom (UK)
Tel.: (01834) 842 803
Fax: (01834) 842 804
E-mail: Audiocom@connect-wales.co.uk

JAPAN
Triode Supply Japan Ltd.
Tel.: (489) 78 7109
Fax: (489) 78 7309
E-mail: triode@postoffice.net.co.jp

SINGAPORE
Zenn Audio Electronics
Tel.: 443 2473
Fax: 443 2479
E-mail: zenn@pacific.net.sg

FRANCE
Next Audio
Tel.: (04) 90 56 76 82
Fax: (04) 90 56 76 82

*Reader Service #6*

estly-priced tube gear as well as a high-quality integrated solid state amplifier. System price, including CD player and cabling, never exceeded $2500. The sound was full, the midrange was tight and powerful, and visitors suspected there was a subwoofer in the room even though there was not.

The SL 60 is designed for full, powerful sound from a small box placed up against a rear wall. It uses the reinforcements found in a typical listening room to achieve this effect. It is not designed to be auditioned or to necessarily provide flat-frequency response in an anechoic chamber.

Kirksaeter offers other models that suit other listening environments as well. The SL 90 monitor, the big brother to the SL 60, uses a 19cm midrange/bass in a larger cabinet that can produce detailed midrange more independently of room considerations. More importantly, the entry level Prisma 55 from the Kirksaeter Prisma series features a soft dome tweeter in the same cabinet as the SL 60. It is capable of the same bass and mid-range response as the high-end SL 60, yet with a soft-dome tweeter.

Kirksaeter dealers have been very successful selling this soft dome bookshelf pair into the A/V receiver environment. It is tempting to use the Silverline series with mid-fi gear because of the relatively low cost for a higher end speaker product, but Kirksaeter dealers can configure the correct speaker and home theater speaker package for a consumer's particular amp/room environment.❖

Ray Kingcaid
Kingcaid Acoustic

**A note on testing:** The Kirksaeter SL-60 was tested in the laboratories of Audio and Acoustics, Ltd. Measurements were made with the MLSSA and CLIO PC-based acoustic data acquisition and analysis systems using an ACO 7012 ½" laboratory-grade condenser microphone with a custom-designed wideband, low-noise preamp. The polar response tests were performed with a computer-controlled OUTLINE turntable on loan from the Old Colony division of Audio Amateur Corporation.

**REFERENCES**

1. J. D'Appolito, *Testing Loudspeakers*, Audio Amateur Corporation, Peterborough, NH, 1998.


# Over 2,000 Tube Types for All Applications

*RECEIVING • SPECIAL PURPOSE • POWER • INDUSTRIAL • ANTIQUE*

★ Highest Quality from the World's Most Popular Manufacturers ★

| TYPE | TYPE | TYPE | TYPE |
|---|---|---|---|
| 3A3C | 6EJ7 | 12AZ7A | 811A |
| 5AR4 | 6GH8A | 12BA6 | 812A |
| 5R4GY | 6GJ7 | 12BE6 | 813 |
| 5U4G | 6HA5 | 12BH7A | 2050/2050A |
| 5Y3GT | 6J5 | 15CW5 | 5749/6BA6W |
| 6AJ8 | 6J7 | 17JZ8 | 5814A |
| 6AL5 | 6JZ8 | 30AE3 | 5881 |
| 6AQ5 | 6K7 | 33GY7A | 5965 |
| 6AU6 | 6SA7 | 35W4 | 6146A/B |
| 6AX5GT | 6SG7 | 38HE7 | 6350 |
| 6BA6 | 6SJ7 | 50C5 | 6463 |
| 6BE6 | 6SK7 | 6267 | |
| 6BH6 | 6SN7GTB | 6973 | |
| 6BL8 | 6SQ7 | 7025A | |
| 6CA4 | 6U8A | 7189A | |
| 6CA7 | 6X4 | 7581A | |
| 6CG3 | 6X5GT | KT88 | |
| 6CX8 | 6X8 | 2D21/EN91 | |
| 6CW5 | 12AT7 | 85A2/0G3 | |
| 6DL5 | 12AU6 | 108C1/0B2 | |
| 6DQ6B | 12AU7 | 150C4/0A2 | |
| 6DR7 | 12AV6 | 572B | |
| 6DX8 | 12AV7 | 805 | |
| 6EA8 | 12AX7A | 807 | |
| 6EH7 | 12AY7 | 810 | |

**VOLUME DISCOUNTS**

Solid State Replacements as low as $4.00

•

*Write or call for complete tube range, price list and accessories catalog.*

VISA

International ©

MasterCard

**International Components Corporation**

175 Marcus Blvd., Hauppauge, NY 11788 • N.Y. State 631-952-9595 • FAX 631-952-9597

Call TOLL FREE **800-645-9154** www.icc107.com

*Reader Service #66*


## Wheatfield Audio HA-2

*from page 41*

Manufacturer's Response:

I appreciate the difficult task that Betty Jane and Richard Honeycutt undertook in reviewing the HA-2 headphone amplifier. It's not easy to characterize sonic differences between amplifiers in a short time. I'm happy to see that the excellent test methodology they used didn't show any problems with the HA-2.

It is a bit disappointing that there weren't more differences discernible between the HA-2 and the control amplifier. Perhaps with different headphones, such as the Sennheiser HD-600s that we use as a reference, more would have been apparent. It is certainly true that the amplifier and headphones together should be listened to, and selected, as a system.

In his portion of the review, Charles Hansen's description, observations, and measurements are perfectly accurate. Hansen did excellent work. This is something that some other "Stereo" magazines should aspire to!

One thing that I would like to mention is that we are now optionally offering the HA-2 with a "premium" NOS tube set, including American 6SN7 input and 7236 output tubes, and a Mullard CV378 rectifier. This combination lowers the output noise as well as the output impedance, making the HA-2 more suitable for driving lower impedance headphones.

My thanks to the staff of *Glass Audio* for providing this fine service. ❖

Pete Millett
Owner
Wheatfield Audio LLC

# audioXPRESS

*is your guide to audio excellence*

Continuing *Glass Audio*, *Audio Electronics*, and *Speaker Builder*

## *When you want the best sound reproduction from your audio system.*

We've gathered the best technologies, tips and projects together into **one monthly source**.

Whether you're craving the highest-quality amplification possible from the best designs, searching for the ultimate solution to your unique listening room challenges, or need the most comprehensive detail about audio components you're ready to buy . . . ***audioXpress*** has been designed for You.

- ***More* Projects**
- ***More* Reviews**
- ***More* Technology Updates**
- ***More* Tips & Techniques**
- ***More* Audio Classroom**

GET READY FOR ***audioXpress***— *YOUR* NEW MAGAZINE!

**Only $29.95 for 12 monthly issues!**

Call 1-888-924-9465 or e-mail custserv@audioXpress.com!

CANADA ADD $12 PER YEAR, OVERSEAS RATE $59.95 PER YEAR.

***ORDER ON-LINE AT www.audioXpress.com***

**Call or E-Mail Today to Request Your FREE Trial Issue!!**

**First Issue To Mail Jan. 2001!**

**audioXpress**, PO Box 876 Dept. G0, Peterborough, NH 03458-0876 USA 888-924-9465 or 603-924-9464
Fax: 603-924-9467 E-mail: custserv@audioXpress.com Web: **www.audioXpress.com**

# GLASSIFIEDS

## VENDORS

**SERVICE/ALIGNMENT** and operating manuals, $12.50; many original parts. Expert restoration/repair service. "***The Fisher Doctor",*** Al Pugliese, 27 Daleham St., Staten Island, NY 10308, (718) 948-7489, AOL: "FISHERDOC."

**The LP track** carries both stereo channels vs. alternating pits on the CD. The LP remains superior with "tight coupling for audio," $15; using an "OTL amplifier circuit," $35; driving efficient "Bass Horn" plans, $50. Visa, MC. ***STEEN AUDIO LAB***, PO Box 2185, Vancouver, BC V6B 3V7, CANADA.

**COPPER AND NON-MAGNETIC STAINLESS STEEL CHASSIS** For the hobbyist and the OEM, the best quality blank or prepunched chassis. See us at http://sites.netscape.net/qualitysoundsupp, or contact us at qltysnd@netscape.net. ***Quality Sound Supplies*, Jean Pierre Magnan, 3980 chemin de Tilly, Saint-Antoine-de Tilly, QC, G0S 2C0, Canada. Fax: 1-418-683-1631**

**Premium Grade Parts**

**Don't Pay More!**

Absolutely the best selection of audiophile grade parts at fair prices! Extensive deep in stock inventory featuring these vendors and *many* more. **Free** catalog! MIT MULTICAP... better selection than any other source WONDER CAP, SOLEN, SCR, REL-CAP, NICHICON MUSE, BLACK GATE, ELNA, CADDOCK, VISHAY, MILLS, HOLCO, RESISTA, Dale, TKD, ALPS, NOBLE, Elma, Shallco, EAR DEFLEX PANELS - ultimate in speaker enclosure damping CARDAS, KIMBER, ACROTECH,,& pure silver chassis wires, HEXFRED diodes, SOLO foil inductors, all types of audio connectors, silver contact toggle & rotary switches, stepped attenuator kits, hospital grade plugs, tubes, tools, IC's, super selection of damping materials & feet. International/overseas orders are especially welcome! Phone (415) 669-7181 or fax (415) 669-7558 for a catalog.

**Michael Percy, Box 526, Inverness, CA 94937**

*Reader Service #21*

**VINTAGE TUBES**

**from the ATTIC**
**JUST ASK . . .**
**C. Ong**
**ATTIC TUBES**
**10223 Valentino Dr. #7304**
**Oakton, VA 22124**
**TEL (703) 255-3218**
**FAX (703) 255-3718**
**ONGKT88@EROLS.COM**

## FOR SALE

AudioClassics.com buys, sells, trades, and repairs high-end audio. (607) 766-3501, 3501 Old Vestal Rd, Vestal, NY 13850.

**www.audioXpress.com**

## WANTED

Vintage tube/newer gear: Altec, Quad, Leak, Fisher, Marantz, Audio Research, CJ, EICO, McIntosh, Levinson, etc. (405) 737-3312, FAX (405) 737-3355.

AudioClassics.com buys, sells, trades, and repairs high-end audio. (607) 766-3501, 3501 Old Vestal Rd, Vestal, NY 13850.

## AD INDEX


| ADVERTISER | PAGE |
|---|---|
| 17.....Antique Electronic Supply | CV3 |
| 3.....Antique Radio Classified | 8 |
| 32.....ATD sas | 17 |
| 25.....Atma-Sphere Music Systems | 27 |
| 105.....Audience | 50 |
| *.....Audio Advancements LLC | 60 |
| Audio Amateur Corp | |
| *..... AudioXpress | 63 |
| *..... Classifieds | 64 |
| *..... Find Audio Excellence | 16 |
| *..... Leak Book | 52 |
| *..... New Tube Books | 54 |
| *..... Yard Sale/Guide Section | 65 |
| 71.....Audio Consulting | 65 |
| 1.....Audio Note North America | 60 |
| 18.....Audio Transformers | 69 |
| 5.....Billington Export Ltd. | 9 |
| 13.....Cary Audio Design | 28 & 29 |
| 40.....Chelmer Valve Company | 56 |
| 61.....Curcio Audio Engineer | 26 |
| 6.....Danish Audio ConnecT Ltd. | 61 |
| 73.....DH Labs, Inc. | 54 |
| 107,108 Divergent Technologies | 44 & 59 |
| 67.....Echo Buster | 52 |
| 100.....EIFL | 11 |
| 57.....Electra-Print | 69 |
| 23.....Electro-Harmonix | CV4 |
| *.....Hagerman Technology | 55 |
| 4.....Halfin SA | 7 |
| *.....Hammond Manufacturing Co. | 15 |
| 60.....Hovland Company | 67 |
| 87.....Int'l Audio Group, Inc. | 57 |
| 66.....International Component | 62 |
| 2.....JJ Electronic | 5 |
| 55.....Laboratoire JC | 13 |
| 33.....Langrex Supplies Ltd. | 58 |
| *.....Mapletree Audio | 65 |
| 52.....Marchand Electronics, Inc | 55 |
| 102.....May Audio | 51 |
| *.....Moth Audio | 59 |
| 85.....NHC Brenner's Corp | 48 |
| 59.....Nirvana Audio Accessories | 67 |
| 10.....Parts Express Int'l., Inc. | 6 |
| 92.....Perpetual Technologies | 3 |
| 70.....Plitron Manufacturing, Inc. | 23 |
| 93.....Power Press Publishing | 65 |
| 96.....Richardson Electronics | 49 |
| 123.....Solen | 47 |
| *.....Stanalog Audio | 53 |
| 99.....STC Navigator | 4 |
| 48.....Sun Audio | 31 |
| 15.....The Parts Connection | 18 & 19 |
| 77.....Thetubestore.com | 70 |
| 68.....Thorens of America | 25 |
| *.....Triode Supply Japan,LTD | 43 |
| 90.....Upscale Audio | 21 |
| 79.....Vacuum Tube Valley | 45 |
| 28.....Vintage Hi-Fi | 69 |
| 45.....Watford Valve | 57 |
| 37.....Welborne Labs | CV2 |
| 109.....Wheatfield Audio | 32 |

**CLASSIFIEDS**

| | |
|---|---|
| *.....Attic Tubes | 64 |
| *.....Audio Classics Ltd. | 64 |
| *.....Jean Pierre Magnan | 64 |
| 21.....Michael Percy Audio Products | 64 |
| *.....Sonny Goldson | 64 |
| *.....Steen Audio Lab | 64 |
| *.....The Fisher Doctor | 64 |

**① Circle the reader service number to receive free material ② print your name and address below ③ answer all of the questions listed below ④ circle the issue number : 1/00 2/00 3/00 4/00 5/00 6/00**

NAME

ADDRESS

CITY/STATE/ZIP

COUNTRY PHONE

Is this your copy of *Glass Audio*? ☐ yes **200.** ☐ no
Are you a subscriber to *Glass Audio*? ☐ yes **201.** ☐ no

1. Check one to describe your total dollar investment in your current home audio system.
**01.** ☐ Under $1,000 **02.** ☐ $1,000-$4,999 **03.** ☐ $5,000-$9,999
**04.** ☐ $10,000-$14,999 **05.** ☐ $15,000-$24,999 **06.** ☐ $25,000 or more

2. Check one to describe your total dollar investment in your current mobile audio system.
**01.** ☐ Under $500 **02.** ☐ $500-$999 **03.** ☐ $1,000-$1,499 **04.** ☐ $1,500-$1,999 **05.** ☐ $2,000 or more

3. Check one to describe what you plan to spend during the next 12 months to replace or upgrade your mobile audio system.
**01.** ☐ Under $250 **02.** ☐ $250-$499 **03.** ☐ $500-$749 **04.** ☐ $750-$999 **05.** ☐ $1000-$1,499 **06.** ☐ $1,500 or more

4. Check one to describe what you will spend for recorded music (DVD's, CD's, cassettes, vinyl) in the next 12 months.
**01.** ☐ Under $250 **02.** ☐ $250-$499 **03.** ☐ $500-$749 **04.** ☐ $750-$999 **05.** ☐ $1000 or more

5. If you purchased this magazine as a single copy, where did you buy it?
**01.** ☐ Bookstore **02.** ☐ Electronics retailer **03.** ☐ Music or record store **04.** ☐ Other

***(THIS CARD EXPIRES 6-30-2001)***

## ADVERTISEMENTS

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
| 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 |
| 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 |
| 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 |
| 99 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 | 112 |
| 113 | 114 | 115 | 116 | 117 | 118 | 119 | 120 | 121 | 122 | 123 | 124 | 125 | 126 |
| 127 | 128 | 129 | 130 | 131 | 132 | 133 | 134 | | | | | | |

## EDITORIAL

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 135 | 136 | 137 | 138 | 139 | 140 | 141 | 142 | 143 | 144 | 145 | 146 | 147 | 148 |
| 149 | 150 | 151 | 152 | 153 | 154 | 155 | 156 | 157 | 158 | 159 | 160 | 161 | 162 |

Postage Required
Post Office will not deliver without proper postage.

**Creative Data**
**519 Briarcliff Road**
**Bolingbrook IL 60440-3003**

# YARDSALE

## FOR SALE

SSM 2000 noise filter compressor, new, featured in *Electronics Now*, $95. Jose Vitale, FAX 407-841-1440, e-mail jovita6@juno.com.

P.S. Audio Ultra Link Two D/A Converter less Ultra Analog D/A, $150. Ashby, eaboo8@email.mot.com or 954-723-5225.

MCI JH16 1″ 8-trk repro head with 85% headlife per JRF, $250. JimKollens@aol.com or (630) 628-0810 (days), (630) 691-8890 (evenings).

## WANTED

3A/167M vacuum tubes. Ashby, eaboo8@email.mot.com.

Schematics for Audio Research LS5MKII or LS5MKIII and LS16 or LS25, Reference Phono and PH1, Convergent Audio Technology SL 1 and Ultimate. Will pay for copying, handling, and postage. Please make an offer on the above or other interesting schematics of high-end equipment. Reinhard Hoffmann, Wiembecker Str. 1, 32657 Germany, Fax 05261 87586, e-mail in.audio@t-online.de.

Schematic and manual for DBX310d. JimKollens@aol.com or (630) 628-0810 (days), (630) 691-8890 (evenings).

Clio or Clio Lite Measuring System. lars.urbans@get2net.dk

Hitachi MOSFET 2SK134/135, 2SJ49/50. Ashby, eaboo8@email.mot.com or 954-723-5225.

**SHARE *your* SHARD**

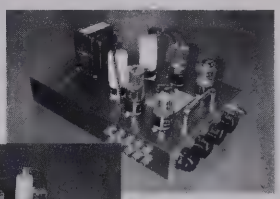
If you are a tube enthusiast, then you probably have information that would be valuable to *Glass Audio* readers. *Glass Audio* encourages your feedback, and we'll pay you a modest stipend* for your efforts. Contribute to the wealth of information in this industry by sending your "Glass Shard", and any accompanying photographs or artwork to:

Glass Audio, *Editorial Department*
*PO Box 876*
*Peterborough, NH 03458*
* $35 for each tip we publish


**AFFORDABLE CLASSIC QUALITY**

MAPLETREE AUDIO DESIGN
*OCTAL 6* PREAMP KITS &
DELUXE ASSEMBLED UNITS

➲ **KIT**
**$375**
plus shipping



➲ **ASSEMBLED**
w/oak base,
tubes,115/230V
**$775** plus shipping

All octal tubes--12J5GT, 12SN7GT, 6R7G/OM4. Two complete line stage circuits (SRPP and cathode follower) plus passive, switchable with any of 3 inputs. Match your favorite circuit to any source. Kit includes all parts, tubes, punched and painted chassis, and 40 page instruction manual.

*Assembled version available exclusively through FSAUDIOWEB (http://www.fsaudioweb.com)*

MAPLETREE MAD AUDIO DESIGN

Dr. Lloyd Peppard
R. R. 1, Seeley's Bay
Ontario, Canada K0H 2N0
(613) 387-3830
peppardl@post.queensu.ca

**http://hollowstate.netfirms.com**



It is not enough to put oil into a Capacitor to make it musical....

KRISTALL

Forget about resistive devices for the volume setting. We offer a silver wired transformer approach

***Silver Rock***
***Transformer-Potentiometer***

It is not enough to use silver wire for a good SE-OPT...

***Silver Rock***
***Output transformer***

**There is only one optimum solution for a given problem.**

Audio Consulting / 14B chemin des Vignes / 1291 Commugny / Switzerland
Fax: 00-41-22-960-12-59 / e-mail: serge.schmidlin@span.ch


Reader Service #71


TUBE AMP BOOKS
*by Kevin O'Connor*

THE ULTIMATE TONE -
Modifying and Custom Building Tube Guitar Amps
368 pgs, 395 figs & schematics — US $55

PRINCIPLES OF POWER -
A Practical Guide to Tube Power Amplifier Design
221 pgs, 210 figs & schematics — US $35

TONNES OF TONE -
Electronic Projects for Guitar & Bass
102 pgs, 65 figs & schematics — US $25

THE ULTIMATE TONE - Volume 2
Systems Approach to Stage Sound Nirvana
252 pgs, 283 figs & schematics — US $40

READY SET GO! -
An Electronics Reference for the Everyman
82 pgs, 43 figs & schematics — US $20

Prices include shipping worldwide!
MC, VISA, check or money order

POWER PRESS PUBLISHING
PO Box 1777, Station B,
London, Ontario, CANADA, N6A 5H9

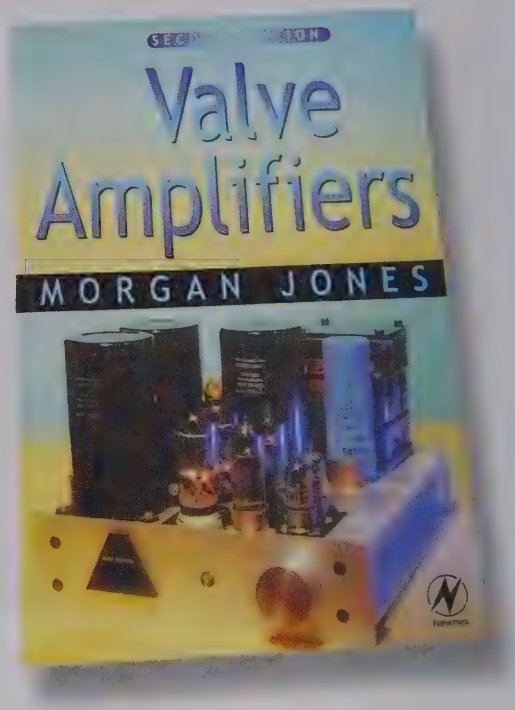
Phone 519-668-3132 FAX 519-668-2055


Reader Service #93

# BOOK REPORT

## *Valve Amplifiers*

*Reviewed by Larry Lisle*




I collect old radio and electronics books. I have most of the standard texts by Van Der Bijl, Chaffee, Eastman, Reich, Valley and Wallman, Langford-Smith and others, and I refer to them often. Reading the classics is great, but reading only the classics cuts you off from everything that's happened in electronics, including tube electronics, since the mid-'50s.

### OVERVIEW

A new edition of a book that's bound to become a modern classic is *Valve Amplifiers* by Morgan Jones (available from Old Colony Sound Laboratory, PO Box 876, Peterborough, NH 03458, 603-924-9464, FAX 603-924-9467, custserv@audioXpress.com, www.audioXpress.com). This is a 488-page work of art ($49.95) that covers the modern techniques of tube amplifier design and construction. While it doesn't cover as many different circuits as the *Radiotron Designer's Handbook, 4th Edition*, it gives a more thorough treatment of those circuits that have become standard practice in the audio community in the years since the *Radiotron 4th* was published.

*Valve Amplifiers* is also a very well-written book. It's evident that the author, a former BBC engineer, took a lot of time polishing the text and presenting the material as clearly as possible. It's also evident that the author actually builds amplifiers. He understands the questions a builder has because he's asked them himself and has worked out the answers.

I'm really impressed by this book. It has something for the individual at the beginner stage, and also for those building the highest quality tube amplifiers. Frequently, other classic texts are referenced for further information. This is one you might wish to read from cover to cover. There's no way to cover adequately the material in a book with almost 500 pages, but I'll do a quick survey of the individual chapters.

### BREAKDOWN OF CHAPTERS

The first is titled "Circuit Analysis" and its contents are found in most textbooks on electronics. Here though, it's very well done; it's very concise and to-the-point. Math is limited to simple algebra.

This is a good chapter to refer to when you wish to refresh your memory on something you once learned but have not used in a while, or if you are not yet fluent in theory. Interestingly, the chapter includes basic semiconductor theory, which might be surprising in a textbook on tubes but the author points out that semiconductors in one form or another are often used in many modern tube amplifiers. Like all the other chapters, this one also includes suggestions for further reading.

The second chapter, "Basic Building Blocks," begins with the usual triode amplifier and graph of anode (plate) characteristics. The author takes you through the steps of drawing a load line and selecting operating conditions. He then goes on to explain methods for determining anode resistance, mutual conductance, and amplification factor.

The next topic is bias, with emphasis on the cathode resistor method. Both bypassed and unbypassed (or "decoupled") cathode resistors are discussed. The choice of value for a gridleak resistor and output coupling capacitor is discussed in the next section. Both are often overlooked in other books.

The author explains the Miller effect and the development of the tetrode and pentode. The British authorship shows here when Jones mentions that the beam tetrode was designed to get around the pentode patent held by a European company. You won't find that in an RCA manual! He also explains why a pentode generates predominantly odd harmonic distortion of a triode. You won't find this information in many other texts.

The text describes the design of a small signal amplifier using an EF86 pentode. An interesting equation Jones provides is how to calculate the "anode resistance" of the screen grid, which is used to determine the value of a screen bypass capacitor for a given cut-off frequency. As a starting point, the author uses data for a pentode connected as a triode, which is usually found in European tube manuals. This information is seldom given in American manuals, but is easy to find by measurement.

Jones compares the pentode to the triode in terms of gain, Miller effect, distortion, and noise. He explains partition noise particularly well.

The chapter continues with a description of the cascode circuit and takes you through the design of a cascode 6DJ8. Excellent material.

Other sections discuss the cathode follower, sources and sinks, the common cathode amplifier as a constant current sink, the cathode follower with an active

load, the White cathode follower, the mu-follower, the differential pair, and transistor constant current sinks. It's absolutely wonderful material, right at the heart of many modern designs, and it's explained with superb clarity. You can understand this stuff. You can build from it.

Chapter 3 is titled "Component Technology." This is the nuts and bolts of amplifiers. Do you "age" your wirewound resistors in your oven before matching them? That's just one of the little bits of useful information you can find here.

Chapter 4 covers the power supply. Lest you skip this chapter, consider what the author has to say: "...it is tempting to think of (power supplies) as an afterthought. It is important to realize that an amplifier is merely a modulator and controls the flow of energy from the power supply to the load. If the power supply is poor, then the most beautifully designed amplifier will be junk."

Chapter 5, "The Power Amplifier," begins with a description of a single-ended power amplifier using an E182CC (US 7119) twin triode. The author states it could be used as a headphone amplifier. He stretches the loadline for maximum output to get around 2W at about 11% distortion at full power, almost all second harmonic. He points out that in single-ended amplifiers the distortion is directly proportional to the level, so at realistic headphone volume this amp might sound very nice.

He goes on to detail the case for and against single-ended triode amplifiers, closing with: "To sum up: single ended triode amplifiers have good low level performance, the bass, and especially midrange, are good, they tend to be low power (typically 10W), and they are outrageously expensive due to the cost of the output transformer and the esoteric valves used." I'm not sure I agree with the "outrageously expensive" part, but perhaps costs and parts availability are different in Britain.

The remainder of the chapter is devoted to push-pull output stages, which is important because push-pull amplifiers are more complicated to design and build than are single-ended amps. There's too much here to even briefly describe, but some of the topics include ultralinear and output transformerless (OTL) design, the driver, and (in great detail) the phase splitter circuitry, the input stage, and stability. A nice touch is the criticism of classic power amplifiers, not with a "how could you be so dumb" attitude, but with hints and advice from those who have gone before. The author closes with a detailed description of several amplifiers of his own, and they are most interesting.

Chapter 6, "The Preamplifier," is by far the most complicated, and there's no way to summarize it adequately. Let's just say that if you intend to ever build a thoroughly top quality preamp, especially if you intend to include RIAA equalization for LP records, you must read this chapter.

Chapter 7, "Construction and Safety," has something for everyone. The beginner should read this chapter before buying a lot of tools or tearing into a chassis. Old-timers can learn something, too. For instance, rotating a transformer or choke so its core is 90° out of line with a nearby transformer is an old technique. However, driving the coil of one transformer from a signal generator and monitoring the signal level picked up in the other (while rotating and positioning both and *before* cutting the chassis) is one idea I hadn't thought of.

Another tip found in the book is to use just one edge of the chassis as a reference and make all measurements from that side when marking out the holes. Even if you've been banging your knuckles on aluminum for years, there's something here for you. The book closes with an appendix full of useful information and a good index.

## CONCLUSION

I have one mild criticism of the book. The cover photograph shows the author's "Daughter of the Beast" amplifier from the "Power Amplifier" chapter. As he says, "rules were broken in the mechanical construction of this amplifier." Actually, the photo makes you wonder whether the author had a grudge against his tubes and capacitors because of the way he put them so close together.

The author does point out that adequate cooling was provided and that the tubes are run only at 40% of ratings. I'm sure the amp works fine and the author had good reason for building it as he did. However, the photo might put off some potential readers who may wonder about the seemingly poor construction practice.

That's the only criticism I have. This is an extremely well-written book and covers modern tube amplifier design as well as any book I've seen. You can delve into the theory or copy one of the author's circuits and modify it. After reading *Valve Amplifiers*, you will understand what Jones' design rationale was and what each part is supposed to do. ❖


HEAR FOR YOURSELF

The film capacitors chosen by many highly acclaimed manufacturers for use in their very best designs.

HOVLAND

MUSICAP®

*"If you want see-thru, high definition, detail and listenability, try the MusiCaps."*
Joe Roberts, **SOUND PRACTICES,** Issue 6

THE ULTIMATE CAP

The most naturally revealing capacitor. Film and foil polypropylene construction. Optimized for critical speakers and vacuum tube electronics. Silver-plated leads. Values from .01 to 10µF. Precision made in USA.

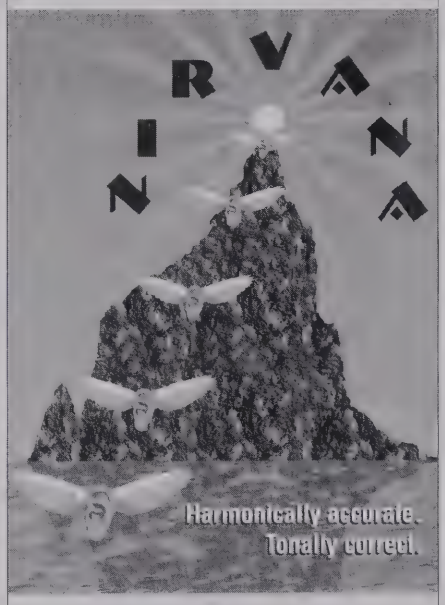
*To experience MusiCaps for yourself, contact:*

- Welborne Labs 303-470-6585
- Madisound Speaker Components 608-831-3433
- Antique Electronic Supply 480-820-5411
- Michael Percy Audio Products 415-669-7181
- The Parts Connection 800-769-0747
- Anchor Cross Co.,Tokyo, Japan 81-3-3203-5606
- Trevor Lees Audio, Australia 61-3-9853-2315
- Wilmslow Audio, England 44-01455-286603
- Tang Hill International Ltd., Taiwan 8862-2-5813605
- Hong Kong Bush, Hong Kong 852-2525-3227
- Audio Parts, Korea 82-2-3272-2704
- Well Audio Lab, Singapore 65-3380368
- Knopf Hi-Fi, Germany 49-0211-33-17-76
- OEMs contact Hovland Company at : ph 209-966-4377 • fax 209-966-4632

www.hovlandcompany.com

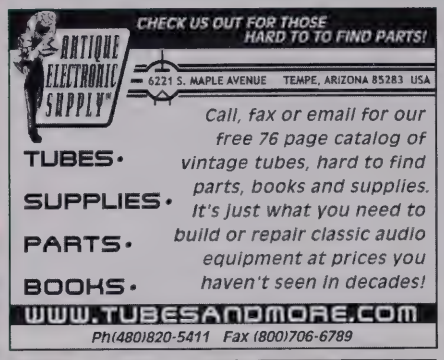
*Reader Service #60*

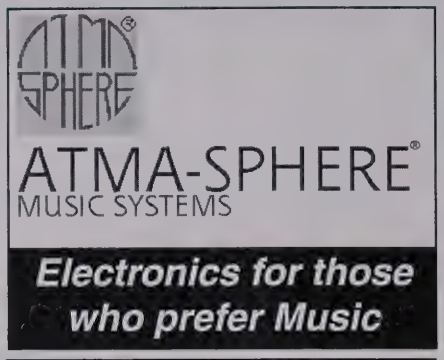
Chassis / Hook-Up Wire




NIRVANA AUDIO
P.O. Box 448
Lynbrook, NY 11563 USA
phone 516-593-4700
fax 516-599-1997
www.NirvanaAudio.com

*Reader Service #59*


ANTIQUE ELECTRONIC SUPPLY
CHECK US OUT FOR THOSE HARD TO TO FIND PARTS!
6221 S. MAPLE AVENUE TEMPE, ARIZONA 85283 USA
TUBES·
SUPPLIES·
PARTS·
BOOKS·
Call, fax or email for our free 76 page catalog of vintage tubes, hard to find parts, books and supplies. It's just what you need to build or repair classic audio equipment at prices you haven't seen in decades!
WWW.TUBESANDMORE.COM
Ph(480)820-5411 Fax (800)706-6789
http://www.tubesandmore.com



http://www.atma-sphere.com

http://www.upscaleaudio.com

http://www.netspace.or.jpl/~eifl/eifl/export/export2.htm

http://www.hagtech.com

http://www.2000apex.com

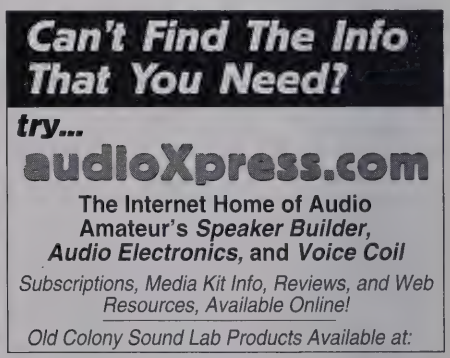
http://www.perpetualtechnologies.com

http://www.plitron.com

http://www.rell.com/audio/index_Aud.asp

http://www.tubes.ru

http://www.sonicfrontiers.com/TPC


Can't Find The Info That You Need?
try...
audioXpress.com
The Internet Home of Audio Amateur's Speaker Builder, Audio Electronics, and Voice Coil
Subscriptions, Media Kit Info, Reviews, and Web Resources, Available Online!
Old Colony Sound Lab Products Available at:
http://www.audioXpress.com

# WEBSITE RESOURCES
*continued*

**Danish Audio Connect**
*http://www.DACT.com*
Stepped audio attenuators, input selectors, phono stage modules, linear amplifier modules, and more.

**Audience**
*http://www.audience-av.com*

**Audio Advancements**
*http://www.audioadvancements.com*

**Audio Consulting**
*http://www.audioconsulting.ch*

**Billington Expo LTD**
*http://www.btinternet.com/~billingtonexportltd*

**Cary Audio Design**
*http://www.audioelectronicsupply.com*

**DH Labs**
*http://www.silversonic.com*

**Divergent Technology**
*http://www.divertech.com*

**Echo Busters**
*http://www.echobusters.com*

**Mapletree Audio**
*http://www.hollowstate.netfirms.com*

**Marchand Electronics**
*http://www.marchandelec.com*

**Moth Audio**
*http://www.mothaudio.com*

**New Sensor Corp**
*http://www.ehx.com*

**Nirvana Audio**
*http://www.NirvanaAudio.com*

**Sun Audio**
*http://www.2.big.or.jp/~sunaudio*

**Vintage Hi-Fi**
*http://www.topnet.it/az/vintagehifi*

**Wheatfield Audio**
*http://www.headphoneamp.com*


ELECTRA-PRINT
AUDIO CO.

S.E. OUTPUT TRANSFORMERS
*Primaries to 10K
*Power up to 100 watts
*-1db 18hz to 40khz typical
*Custom designs available
PUSH-PULL OUTPUTS
*Built for triodes
*Single output to load
INTERSTAGE TRANSFORMERS
*Full bandwidth, up to 60ma
*Single plate to P-P grids
LINE OUTPUTS
*Full bandwidth, up to 60ma
POWER TRANSFORMERS
*Custom built to your requirements
*Power supply design advice
CHOKES/FILTER and AUDIO
*Standard and custom HV filter chokes
*High current filament chokes
*High inductance audio plate chokes

*specification and pricing catalog available*
*Visa,MC and Amex*

ELECTRA-PRINT AUDIO CO.
4117 ROXANNE DR., LAS VEGAS, NV 89108
702-396-4909 FAX 702-396-4910
EMAIL electaudio@aol.com

*Reader Service #57*

# AUDIO TRANSFORMERS

*AMERICA'S PREMIER COIL WINDER*

**Engineering • Rewinding • Prototypes**

**McINTOSH - MARANTZ - HARMAN-KARDON**
**WESTERN ELECTRIC - TRIAD - ACROSOUND**
**FISHER - CHICAGO - STANCOR - DYNACO**
**LANGEVIN - PEERLESS - FENDER - MARSHALL**
**ELECTROSTATIC SPEAKER TRANSFORMERS**

***Williamson Amplifier Transformer Specialist***

**WE DESIGN AND BUILD TRANSFORMERS**
**FOR ANY POWER AMPLIFIER TUBE**

**PHONE: [414] 774-6625 FAX: [414] 774-4425**

**AUDIO TRANSFORMERS**
**185 NORTH 85th STREET**
**WAUWATOSA, WI 53226-4601**
**E-mail: AUTRAN@AOL.com**

**NO CATALOG** **CUSTOM WORK**

*Reader Service #18*

# Vintage Hi-Fi

*TUBES*: AVVT, Svetlana, Sovtek, JJ, Amperex, CVC, Valve Art, NOS & JAN, transmitting and power tubes.
*TRANSFORMERS*: Oyster Italy & Hammond Canada, main & opt.
*CAPACITORS*: ICAR SP25, the best paper in oil ever made! Ampohm UK
*RESISTORS*: Kiwame JAPAN.

***Vintage amps & KITS!!!***

VINTAGE Hi-Fi
Via Adda 7
63031 Castel di Lama AP ITALY
Tel/fax ++39 0736 812118
*** MAIL ORDER ***

**www.topnet.it/az/vintagehifi**

*Reader Service #28*

# GLASS SHARD

## *A Rozenblit Preamp*

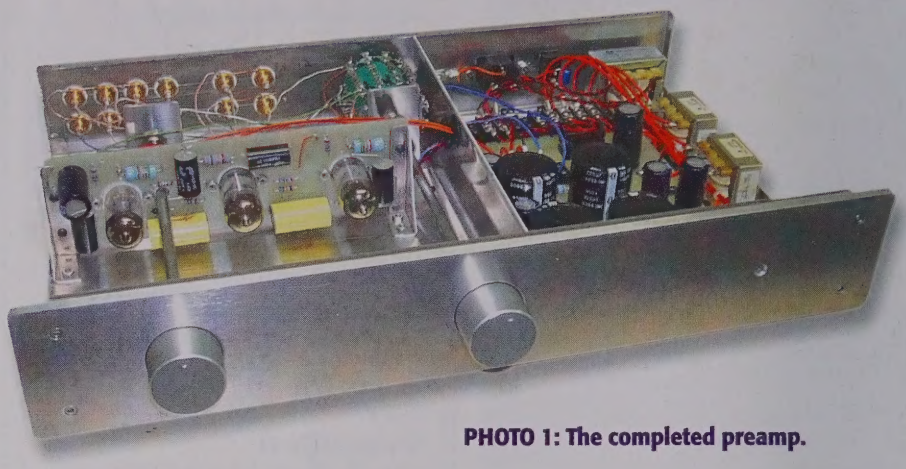


**PHOTO 1: The completed preamp.**

I purchased Bruce Rozenblit's book, *Audio Reality* (available from Old Colony Sound Lab, 603-924-9464, custserv@audioXpress.com), which has schematics of all his products and projects he built for himself. I had been using his preamp design from a *GA* article in '92 and thought it was time to upgrade my preamp.

I've built several preamps and amps before, but this was the first time I used the 3/32" fiberglass board to mount and wire all my components together. I made a scale 2D silhouette of all the required components in a drawing program on my Mac. I then color-coded the components, including tube sockets with pin numbers, resistors, caps, regulators, terminal boards, the works.

I then made an outline of the size of the board I thought I would need and placed the components on the outline trying to minimize interference between components and lead length. Since the drawing program is object-oriented, it allowed me to experiment at will with the board size, connections, and parts placement until I thought I had the optimal layout.

Next I drilled the holes for mounting the components and wired them together on the back of the board. Most of the time I wired them together with the leads from the components themselves, the exception being the ground return.

When wires must cross I simply ran one of the wires on the component side of the board. I used flea clips to terminate those connections that required connection to another board. I attached the B+ and ground leads from the amplifier board to the power supply via a terminal strip.

I also attached my AC inputs as well as grounds to the power supply via a terminal strip, which facilitates removal of the board for tweaking and component upgrading. I soldered only my signal inputs and outputs to chassis-mounted components.

I am very happy with the resulting sound and appearance. ❖

Fred Slaven
Sacramento, CA

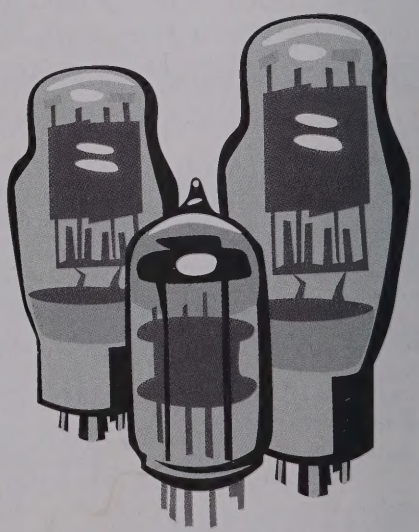

thetubestore.com

Your online source for name brand audio tubes

Enjoy the convenience of purchasing audio tubes at our secure online webstore. We stock a wide range of products, including Ei, Tesla/JJ, Svetlana, Sovtek, Sino, and JAN.

Competitive prices and fast service.

Check out the selection at thetubestore.com



Reader Service #77

6221 S. Maple Ave. Tempe, AZ 85283 · USA
(480) 820-5411 · fax (480) 820-4643 or (800) 706-6789

www.tubesandmore.com
info@tubesandmore.com

# ALL of our tubes are guaranteed to be Y2K compliant!

## Transformers:

Hard to find power, filament and output transformers as well as filter chokes for tube equipment. We feature One Electron and Hammond transformers, and can special order any Hammond transformer you need. We also carry many hard to find New-Old-Stock items.

## Capacitors:

Multi-section, ceramic discs, silver mica, computer grade, variable and trimmer, Wima Orange-Drop, Solen, Sprague Atom, and metallized poly- propylene and polyester are just some of the wide variety of capacitors we offer.

## Supplies:

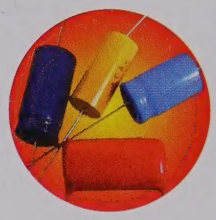
Viabrapods, grill cloth, guitar and amp cloth, cabinet restoration supplies, batteries, vibrators, chemicals, tools, test meters, decals, tube boxes and cartons, hardware, handles, rubber feet and grommets, gifts and kits.

## Literature:

Extensive selection of books and literature on topics such as vacuum tubes, radio collecting, audio, guitar, TV, phonograph and jukeboxes. We also offer many schematic and wire diagrams as well as many how-to books. Many of our items are not available elsewhere!

## Tubes:

Over 3500 audio, receiving, transmitting, and industrial types in stock, including many foreign and early types. We offer the complete line of Svetlana audio, amateur radio and industrial power tubes. We also have tube sets for popular radios and amplifiers!

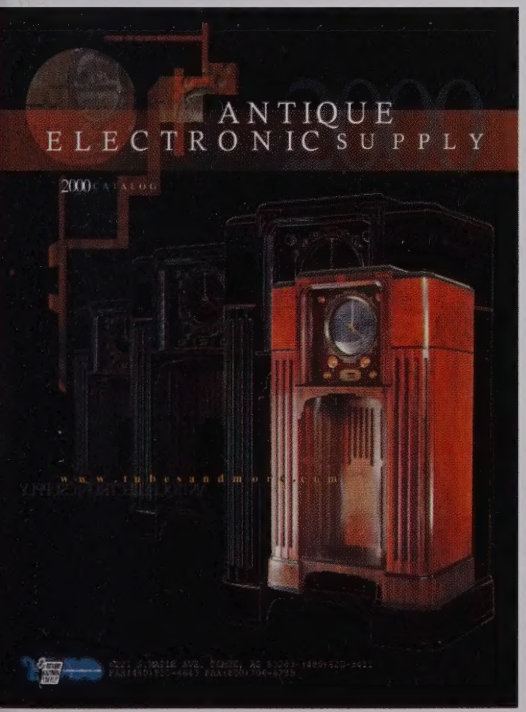


## Parts:

Resistors, tubes sockets, potentiometers, chassis boxes and aluminum enclosures, knobs, dial belts, lamps, diodes, speakers (Jensen, Eminence, Kendrick), wire, ferrite rods, dial cord, attenuators, and reverb tanks. We offer many more items that are too numerous to list.

## FREE!

72 pages of products, some of which are shown "emitting" through grid wires on our catalog cover. We carry the products you expect and many more that may surprise you!




CALL E-MAIL OR FAX FOR YOUR FREE CATALOG TODAY!

JENSEN

one electron™

**Single Ended**
**Output & Power transformers**

EMINENCE

**UBT-1** - Designed for parallel operation of 2A3s, EL34s, 300Bs, 6AS7s, etc. or sweep-tube in "enhanced triode" mode. 1.6k primary, 15watts, 160mA.

**UBT-2** - For use with single 300B, 50, SV811-3, etc. 4.8k primary, 15watts, 110mA.

HAMMOND MANUFACTURING™

Designed for single or parallel operation of 2A3s, 300Bs, 50s, etc. 3.0k primary, 15watts, 110mA.

Svetlana
ELECTRON DEVICES

**BFT-1** - Designed to power a stereo amplifier using a **UBT-1** in each channel, but can also be used to power an 80watt push-pull amplifier. Primary arrangement allows for use virtually anywhere in the world.

XICON™

OEM and quantity discounts available on all types, starting at 4 pieces of each type.

*Reader Service #17*

# electro-harmonix

## SOULFUL TUBES FOR THE STARS

### 12AX7EH

**Forget about Telefunken!** The 12AX7EH provides high gain with ultra low noise and detailed, musical tone that rivals the most desirable NOS types. Unique spiral filament eliminates filament to cathode induced hum common on amps that use AC on the filaments.

### 6V6EH

**Sweet, singing tone for high plate voltage amps!** The all-new 6V6EH combines a specially developed cathode coating, careful alignment of the grids and tri-alloy plate material to create a rugged, wonderful sounding 6V6 that performs flawlessly up to 475 volts. Perfect for high plate voltage amps like the Fender Deluxe Reverb™.

### 6L6EH

**Better than the RCA!** Modeled after the vintage RCA 6L6GC "blackplate", the 6L6EH features larger plate dimensions and improved grid structure for increased power handling capabilities. Also features mica spacers with metal springs to eliminate tube rattle and microphonics. The 6L6EH offers tone and performance superior to any other 6L6 or KT66 type.

### EL34EH

**Mullard reincarnated!** With the new EL34EH, Marshall™ amp owners can recreate the balanced tone, deep, tight bass, sweet mids, and well-defined highs of the original equipment Mullards. Innovative design and precision construction give the EL34EH exceptionally smooth tone and an ideal balance of pleasing even-order harmonics while virtually eliminating undesirable odd-order harmonics.

www.ehx.com

**Available at leading music stores and service shops throughout the world!**

Reader Service #23